THE

ANATOMY

OF THE

HUMAN BONES, NERVES,

AND

LACTEAL SAC AND DUCT.

By ALEXANDER MONRO, *ſenior*, M. D. and F. R. S,
Fellow of the Royal College of Phyſicians, and
Profeſſor of Medicine and Anatomy in the
Uiverſity of Edinburgh.

A NEW EDITION.

TO WHICH IS ADDED,

AN

ESSAY

ON

COMPARATIVE ANATOMY.

EDINBURGH:

Printed for W. GORDON, Parliament-Square,
J. DICKSON, Front of the Exchange.

M,DCC,LXXXII.

TO THE

STUDENTS of ANATOMY

IN THE

UNIVERSITY of EDINBURGH.

GENTLEMEN,

WHEN this *Osteology* was first printed in 1726, I did not know that Albinus, Winslow, and Palfyn, were to publish descriptions of the bones; otherwise, my papers probably would have remained yet undelivered to the printers. I however flatter myself, that this *essay* has been of use to the gentlemen who did me the honour to attend my lectures, by assisting them to understand my sense and representation of things in this fundamental part of anatomy; and that it has possibly been of more advantage to them than a more complete work from an abler hand, unless my demonstrations had been in the order and method of such an author.

This view of your improvement, Gentlemen, is a prevailing argument with me to cause this essay to be reprinted; and you cannot reasonably blame me, if I likewise acknowledge another motive for it, which more particularly relates to myself. In a new edition, an author

has an opportunity of making his works more correct, complete, and consequently acceptable to the public, who may perhaps be indulgent enough to think this little treatise not altogether useless; since more reasoning on the structure and morbid *phænomena* of bones is to be found in it, than in the other writers, who have confined themselves almost entirely to the descriptive or proper anatomical part of the *osteology*.

I have here kept to the plan of the former editions, by first considering, in the order that seemed to me most natural and methodical, every thing which I thought necessary to be known concerning bones in general; and, in the second part, I have described the several bones composing the skeleton.

The bones of adults are what I principally endeavour to describe; but I have added as much of the *osteogenea* as I think serviceable in the practice of physic and surgery.

That little might be omitted of what was formerly done on this subject, I have taken all the assistance I could from books; but have never asserted any anatomical fact on their authority, without consulting nature, from which all the descriptions are made; and therefore, the quotations from such books serve only to do justice to the authors, who have remarked any thing in the structure of the parts that was commonly omitted, and to initiate you in the history of anatomy; which I once proposed to make complete, so far as related to this subject: But not being able to procure several books,

and

and being fenfible how many more may have never come to my knowledge, I laid afide this defign, of purpofe omitted many I could have inferted, and in fome places I have changed an older author for a later one, who has more fully or clearly defcribed what I treated of. Befide anatomifts, I have alfo named feveral other authors to confirm my reafoning by practical cafes; of which it is not to be fuppofed my own experience could furnifh a fufficient variety.

You will readily obferve, that I quote no paffages with a view to criticife or condemn them. This precaution of giving no offence, is very neceffary in thofe who are fufficiently confcious of their being liable to lay themfelves open to juft cenfure; and it prevents occafions of ufelefs wrangling, in which generally both parties are lofers, and the public has little advantage.

In this treatife I always make ufe of the moft common name of each part, and have put the fynonimous names to be met with in books at the foot of the page, that the reading might be fmoother, and you might confult them at your leifure to affift you in underftanding different authors.

The defcriptions and reafoning are here blended, without which I always find young anatomifts are foon difgufted with authors: Their imaginations cannot follow a long chain of defcriptions, efpecially when they are not taught at the fame time the ufes which the defcribed parts ferve: Their minds muft have fome re-

laxation, by a mixture of reafoning, which never miffes to ftrike the fancy agreeably, and raifes a ftrong defire to underftand the principles on which it depends.

The *phænomena* of difeafes are all deduced in this effay from the ftructure of the parts, by way of corollaries and queftions; which fuch an anatomical work confined me to. And this method has otherwife a good effect: For, when one meets with an ufeful propofition, and is obliged to employ a little thought to find out its folution, the impreffion it makes is deeper, and he acquires a fondnefs for it, as being, in part, his own difcovery. My pupils have frequently affured me, that they could, with very fmall reflection, trace out the whole reafoning from which my conclufions were drawn; I hope their fucceffors will alfo think this an agreeable manner of being inftructed.

Thofe gentlemen who defired I would add the lectures which I pronounce in my colleges as a commentary upon the text, where the difeafes are mentioned, will, I perfuade myfelf, excufe me for not complying with their defire, when they confider the defign of this is to be a fchool-book, and how great the difference is between inftructing youth in private, and pretending to inform the public. *Art.* xxiv. *vol.* v. of Medical Effays and Obfervations, publifhed in this place, is one of thefe lectures which I gave as a commentary on the paragraph (p. 9.) concerning the different kinds of *caries*.

In this edition, I have corrected the miftakes and obfcure paffages which I difcovered in the former;

former; and, in ſome places, I have made the deſcriptions more full and exact, aiming all I could to ſhun unneceſſary minuteneſs on the one hand, and a blameable inaccuracy on the other: Whether I have hit that juſt medium, is what you and the public muſt now judge.

I am ſtill of opinion, that figures of the bones would at any rate have been unneceſſary in a book that is intended to be illuſtrated and explained by the originals themſelves; but would be much more ſo now, when my late ingenious friend Mr. Cheſelden, Dr. Albinus, and Mr. Sue (*a*), have publiſhed ſuch elegant ones.

You have advantageous opportunities in this place of ſtudying all parts of medicine, under the profeſſors of its different branches in the Univerſity, and of ſeeing the practice of pharmacy, ſurgery, and phyſic, with our ſurgeon-apothecaries, and in the Royal Infirmary, where the diſeaſed poor are carefully treated. Theſe, your intereſt, and, I hope, your inclinations, will lead you, Gentlemen, ſo to improve, as that they may become the happy means of your making a conſiderable figure in your ſeveral ſtations. Whatever aſſiſtance is in my power towards ſuch a deſirable event, ſhall be given with the greateſt pleaſure by

Your humble ſervant,

ALEX. MONRO.

(*a*) Traité d'oſteologie, traduit de l'Anglois de M. Monro, ſeconde partie.

THE

ANATOMY

OF THE

HUMAN BONES.

PART I.

Of the BONES in general.

BONES are covered by a membrane, named, on that account, PERIOSTEUM*, which is ſo neceſſary to them, that we muſt examine its texture and uſes, before we can underſtand their ſtructure.

The *perioſteum*, as well as moſt other membranes, can be divided into *layers* of fibres. The *exterior* ones, compoſed of the fibres of the muſcles connected to the bones, vary in their number, ſize, and direction, and conſequently, occaſion a very great difference in the thickneſs and ſtrength of the *perioſteum* of different bones, and even of the different parts of the ſame bone. The *internal* layer is every where nearly of a ſimilar ſtructure, and has its fibres in the ſame direction with thoſe of the bone to which they are contiguous. Ought not then the name *perioſteum* to be applied, ſtrictly ſpeaking, only to this internal layer, to which the others are joined in an uncertain manner and number?

 Some

* Membrana circumoſſalis, omentum oſſibus impoſitum.

Some authors (*a*) endeavour to prove the internal layer of fibres of the *periosteum* to be derived from the *dura mater*: For, say they, since the membrane covering the scull is plainly a production or continuation of the *dura mater*, which passes out between the sutures; and since there are muscles on the head, as well as in other parts, which might furnish a *periosteum*, it is needless to assign different origins to membranes which have the same texture and uses. They add further, in proof of this doctrine, that the *periosteum* extends itself along the ligaments of the articulations from one bone to another; and therefore is continued from its origin over all the bones of the body.—While anatomists were fond of the hypothesis of all membranes being derived from one or other of the two that cover the brain, a dispute of this kind might be thought of consequence: But, now that the hypothesis is neglected as useless, it is needless to examine the arguments for or against it.

Except where muscles, cartilages, or ligaments, are inserted into the *periosteum*, its external surface is connected to the surrounding parts by thin cellular membranes, which can easily be stretched considerably, but shorten themselves whenever the stretching force is removed. When these membranes are cut off or broken, they collapse into such a small space, that the surface of the *periosteum* seems smooth and equal.

When we attempt to tear off the *periosteum* from bones, we see a great number of white threads produced from the membrane into them; and, after a successful injection of the arteries with a red liquor, numerous vessels are not only seen on the *periosteum* (*b*), but most of the fibres sent from the membrane to the bone, shew themselves to be vessels entering it, with the injected liquor in them; and when they are broken, by tearing off the *periosteum*, the

(*a*) Havers Osteolog. nov. disc. 1. p. 16.
(*b*) Ruysch. epist. 5. tab. 5. fig. 1, 2. epist. 8. tab. 9. fig. 1, 9.

the ſurface of the bone is almoſt covered with red points.

The veins correſponding to theſe arteries are ſometimes to be ſeen in ſubjects that die with their veſſels full of blood; though ſuch numerous ramifications of them, as of the arteries, can ſeldom be demonſtrated, becauſe few of them naturally contain coloured liquors, and ſuch liquors can difficultly be injected into them. This, however, is ſometimes done (*a*).

The great ſenſibility of the *perioſteum* in the deep-ſeated ſpecies of *paronychia*, in *exoſtoſes*, *nodi*, *tophi*, and *gummata*, from a *lues venerea*, or whenever this membrane is in an inflamed ſtate, is a ſufficient proof that it is well provided with nerves, though they are perhaps too ſmall to be traced upon it; and therefore, one cannot well determine, whether they are ſent along with the arteries in the common way, or are derived from the tendinous fibres of the muſcles expanded on the *perioſteum* (*b*).

Veſſels alſo paſs through the *perioſteum* to the marrow; of which more hereafter. And frequently muſcles, ligaments, or cartilages, pierce through the *perioſteum*, to be inſerted into the bones.

The chief uſes of the *perioſteum* are, 1. To allow the muſcles, when they contract or are ſtretched, to move and ſlide eaſily upon the bones; the ſmooth ſurface of this membrane preventing any ill effects of their friction upon each other. 2. To keep in due order, and to ſupport the veſſels in their paſſage to the bones. 3. By being firmly braced on the bones, to aſſiſt in ſetting limits to their increaſe, and to check their overgrowth. 4. To ſtrengthen the conjunction of the bones with their *epiphyſes*, ligaments, and cartilages, which are eaſily ſeparated in

(*a*) Sue traité d'oſteologie, traduit de l'Anglois de Mr. Monro. Note in page 9.

(*b*) *See* the diſpute about the ſenſibility of this and of other membranes in Zimmerman. Diſſert. de irritabilit.—Act. Goting. vol. 2.—Haller ſur la nature ſenſible et irritable.—Whytt's phyſiolog. eſſay II.—Remar. diſſert. de fungo articulor. § 26. 34.

in young creatures, when this membrane is taken away. 5. To afford convenient origin and infertion to feveral mufcles which are fixed to this membrane. And, *laftly*, To warn us when any injury is offered to the parts it covers; which, being infenfible, might otherwife be deftroyed without our knowledge, or endeavouring to procure a remedy.

When the cellular fubftance connecting the *periofteum* to the furrounding parts is deftroyed, thefe parts are fixed to that membrane, and lofe the fliding motion they had upon it; as we fee daily in iffues, or any other tedious fuppurations near a bone.—When the veffels which go from the *periofteum* to the bones are broken or eroded, a collection of liquor is made between them, which produces a fordid ulcer or rotten bone. This often is the cafe after fractures of bones, and inflammations of the *periofteum*, or after *fmall pox*, *meafles*, *fpotted fevers*, and *eryfipelas*.—Do not the diforders of the *periofteum*, coming rather along with, or foon after the cutaneous than other difeafes, indicate fome fimilarity of ftructure in the *periofteum* and fkin?

The Bones are the moft hard and folid parts of the body, and, as all other parts where large veffels do not enter, are generally of a white colour; only in a living creature they are blueifh, which is owing to the blood in the fmall veffels under their furface. The lefs, therefore, and fewer the veffels are, and the thicker and firmer the bony furface covering the veffels is, the bones are whiter. Hence the bones of adults are whiter than thofe of children; and, in both young and old, the white colour of different bones, or of the feveral parts of the fame bone, is always in proportion to their veffels and folidities; which circumftances ought to be regarded by furgeons, when they are to judge of the condition of bones laid bare.

Bones are compofed of a great many *plates* *, each of which is made up of fibres or ftrings united by fmaller

* Squamæ, bracteæ, laminæ.

ſmaller fibrils (*a*); which being irregularly diſpoſed, and interwoven with the other larger fibres, make a reticular work.—This texture is plainly ſeen in the bones of fœtuſes, which have not their parts cloſely compacted, and in the bones of adults which have been burnt, long expoſed to the weather, or whoſe compoſition has been made looſe by diſeaſes.—The chinks which are generally made, according to the direction of the larger fibres of bones that have undergone the action of fire, or of the weather, ſhew the greater ſtrength of theſe than of the fibres which connect them.—Numerous accurate obſervations of the different times in which exfoliations are made from the ſides or ends of ſimilar bones, might bid fair to determine what is the proportional force of cohesion in the two ſorts of fibres.

The plates are ſaid (*b*) to be firmly joined to each other by a great number of *claviculi*, or ſmall bony proceſſes, which, riſing from the inner plates, pierce through ſome, and are fixed into the more external ones. Of theſe nails four kinds, *viz. the perpendicular*, *oblique*, *headed*, and *crooked*, have been deſcribed: But in bones fitly prepared, I could only ſee numerous irregular proceſſes riſing out from the plates (*c*).

Though the exterior part of bones is compoſed of firm compact plates, yet they are all more or leſs cavernous internally. In ſome (*e. g.* middle thin part of the *ſcapula* and *os ilium*) the ſolid ſides are brought ſo near, that little cavity can be ſeen; and in others (middle of *os humeri*, *femoris*, &c.) the cavities are ſo large, that ſuch bones are generally eſteemed to be hollow or fiſtular. But the internal ſpongy texture is evident in young animals; and ſome of it may be ſeen to remain in thoſe of greateſt age, when bones are cautiouſly opened after they have been kept ſo long as to be free of the oil they contain, or after being burnt.

(*a*) Malpigh. Anat. plant. et oper. poſth.
(*b*) Gagliard. Anat. oſſium, nov. invent. illuſtrat. cap. 1. obſ. 2.
(*c*) Malpigh. oper. poſthum.

This ſpongy cavernous internal part of bones, is generally called their *cancelli* or LATTICE-WORK, and is formed in the following manner. The plates are firmly joined about the middle of the bone: but as they are extended towards its ends, the more internal plates ſeparate from the exterior, and ſtretch out their fibres towards the axis of the bone, where they are interwoven with the fibres of other plates that have been ſent off in the ſame way. Seeing the plates are thus conſtantly going off, the ſolid ſides of the bones muſt become thinner, and the lattice-work muſt be thicker and ſtronger towards their ends. This is evident in many of them, where the ſolid ſides of their middle are very thick, and the *cancelli* are ſcarce obſervable; whereas, at the ends, where their diameter is greateſt, the ſolid walls or ſides are not thicker than paper, and the *cancelli* are numerous and large enough to fill up the whole ſpace left between the ſides.

The twiſting and windings which theſe *cancelli* make, and the interſtices which they leave, differ conſiderably in figure, number, and ſize; and therefore form little cells, which are as different, but communicate with each other. Some writers (*a*) minutely remark theſe different appearances of the *cancelli*, after they begin to ſeparate from the plates; and from thence diſtinguiſh them into *wrinkled*, *perforated*, and *net-like*.

The *cancelli* ſuſtain the membranous bags of the marrow which are ſtretched upon them, and thereby hinder theſe membranous parts to be torn or removed out of their proper places, in the violent motions and different poſtures which the bones are employed in. This ſupport which the *cancelli* afford the marrow, alſo ſaves its membranes and veſſels, in the lower parts of the bones, from being compreſſed by the weight of the marrow above.

The depreſſions between the fibres of the external plates of bones appear like ſo many furrows on their ſurface,

(*a*) Gagliar, Anat. oſſium, cap. 1. obſ. 4, 5, 6, 7.

ſurface, into each of which the *perioſteum* enters; by which the ſurface of contact, conſequently the coheſion, between it and the bone, is conſiderably increaſed, and a greater number of veſſels is ſent from it into the bone, than if it was a plain ſurface.

Both on the ridges and furrows, numerous little pits or orifices of canals are to be ſeen, by which the veſſels paſs to and from the bones.

After a ſucceſsful injection, the arteries can be traced in their courſe from the pits to the plates and fibres; and, in ſawing, cutting, or raſping the bones of living creatures, theſe veſſels diſcover themſelves, by the ſmall drops of blood which then ooze out from the moſt ſolid part of the bones. But the cleareſt demonſtration of the intimate diſtribution of theſe ſmall arteries, is, to obſerve the effect of ſuch a tinging ſubſtance as can retain its colour, when ſwallowed, digeſted, and mixed with the blood of any living animal, and at the ſame time has particles ſmall enough to be conveyed into the veſſels of the bones; ſuch is *rubia tinctorum*, madder root (*a*): For we ſee the gradual advances which this tincture makes from the *perioſteum* into the more internal parts of the bones, and how univerſally the diſtribution of the liquors is made, the whole bony ſubſtance being tinged. Whether the time in which this tinged liquor paſſes from the outer to the internal plates, till all the plates are made of its colour, and the time which the diſappearing of the dye, after giving the creature no more of this ſort of food, makes us think it takes to return, are the ſame in which the natural liquors circulate, is uncertain; becauſe this tinging ſubſtance may move more ſlowly, or may paſs more quickly, than the natural liquors do.—The arteries are larger near each end than at the middle of the large bones that are much moved; becauſe they not only ſerve the bony plates near the ends, but paſs through them to the marrow.—As animals advance in

(*a*) Philoſoph. tranſact. Num. 442. art. 8. Num. 443. art. 2. Num. 457. art. 4.—Mem. de l'Acad. des ſciences, 1739, 1742.

in age, the arteries of the bones become leſs capacious; as is evident, 1. From the bones of adults having leſs blood in them than thoſe of children have. 2. From many of them becoming incapable in old age of admitting the coloured powders uſed in injections, which eaſily paſs in youth. And, 3. From the bones of old creatures being more difficultly tinged with madder than thoſe of young ones.—If authors have not miſtaken, the arteries of bones have ſometimes become very large (*a*).

We may conclude from arteries being accompanied with veins ſo far as we can trace them in every other part of the body, that there are alſo veins in the bones; and the diſappearing of the tincture of *madder*, after bones of living animals are coloured with it, could not be without ſuch veins to carry it away; nay, the veins of bones can ſometimes be injected, and then ſeen (*b*).

The bones of a living animal are ſo inſenſible, that they can be cut, raſped, or burnt, without putting the creature to pain, and the nerves diſtributed in their ſubſtance cannot be ſhewn by diſſection; from which it might be inferred that they have no nerves diſtributed to them: But the general tenor of nature, which beſtows nerves to all the other parts, ſhould prevent our drawing ſuch a concluſion. And if ſenſibility is a ſure proof of nerves entering into the compoſition of any part, as it is generally allowed to be, we have ſufficient evidence of nerves here in the bones; for the granulated red fleſh which ſprouts out from them, after an amputation of a limb, or performing the operation of the *trepan*, or after an *exfoliation*, is exquiſitely ſenſible: And, in ſome ulcers of bones, where the *perioſteum* was all ſeparated, the patient ſuffered racking pain, if the bone was touched with a rough inſtrument; nor was he free of pain after the bone was perforated (*a*)—The reaſon why the

(*a*) Diemerbroek Anat. lib. 9. cap. 1.—Mery. Hiſt. de l'Acad. des ſciences, 1704.

(*b*) Sue trad. d'oſteolog. p. 9.

(*a*) Nicol. Maſſa lib. introd. anat. cap. 30.

the nerves of rigid hard bones become infenfible, is, That all nerves muft have a confiderable degree of flexibility at the part where objects are applied, otherwife it cannot be affected by their impreffions. We fee this illuftrated in a very common analogous cafe, the growth of a new nail: When the former one has fuppurated off, the thin membrane which firft appears, is exquifitely fenfible; but gradually becomes dull in its fenfation, till it can be cut or fcraped, without caufing pain, after it is formed into a hard nail.

From what has been faid of the veffels of bones, it is evident, that there is a conftant circulation of fluids in every part of them; and that there is a perpetual wafte and renewal of the particles which compofe the folid fibres of bones, as well as of other parts of the body; the addition from the fluids exceeding the wafte during the growth of the bones; the renewal and wafte keeping pretty near *par* in adult middle age; and the wafte exceeding the fupply from the liquors in old age; as is demonftrable from their weight: For each bone increafes in weight, as a perfon approaches to maturity; continues of nearly the fame weight till old age begins, and then becomes lighter.—The fpecific gravity of the folid fides, on the contrary, increafes by age; for then they become more hard, compact, and denfe. In confequence of this, the bones of old people are thinner and firmer in their fides, and have larger cavities than thofe of young perfons.

The vafcular texture of bones muft make them fubject to *obftructions*, *ecchymofes*, *ulcers*, *gangrenes*, and moft other difeafes which the fofter parts are affected with; and therefore there may be a greater variety of *caries* than is commonly defcribed (*a*).

Hence we can account for the following appearances.

Hæmorrhagies from fungous flefh rifing out from the moft folid part of a cut bone (*b*).

The

(*a*) Edinburgh Medical effays and obf. vol. 5. art. 25.
(*b*) Medical effays, vol. 4. art. 21.

The regular alternate elevation and ſubſiding, or apparent pulſation, frequently to be ſeen in ſome of the cells of a carious bone.

Cells reſembling *cancelli*, ſometimes ſeen in the part of a bone, which, in a natural ſtate, is the moſt ſolid and firm (*c*).

A bone as a tube including another bone within it (*d*).

On the internal ſurface of the ſolid parts of bones, there are orifices of canals, which paſs outwards through the plates to open into other canals that are in a longitudinal direction, from which other *tranſverſe* paſſages go out to terminate in other *longitudinal* canals; and this ſtructure is continued through the whole ſubſtance of bones, both theſe kinds of canals becoming ſmaller gradually as they approach the outer ſurface (*a*).—Theſe canals are to be ſeen to the beſt advantage in a bone burnt till it is white: When it is broken tranſverſely, the orifices of the *longitudinal* canals are in view; and when we ſeparate the plates, the *tranſverſe* ones are to be obſerved. Here however we are in danger of believing both theſe ſorts of canals more numerous than they really are; becauſe the holes made by the proceſſes connecting the plates of bones, have the appearance of the *tranſverſe* (*b*), and the paſſages for the blood-veſſels reſemble the *longitudinal* canals. I do not know how we are to keep free of error about the *tranſverſe* canals; but think we may diſtinguiſh between the two kinds of *longitudinal* ones; for the paſſages of the veſſels are largeſt near the external ſurface of the bone, and every tranſverſe ſection of them is circular; whereas the *longitudinal canals* are largeſt near the *cancelli*, and their tranſverſe ſections appear to me of a flat oval figure, which may be owing to the different *momentum* of the fluids conveyed in them.—The ſituation of the larger longitudinal canals, and of the paſſages of the larger veſſels,

(*c*) Ruyſch. Theſ. 8. num. 8. Theſ. 10. num. 176.
(*d*) Idem, ibid.
(*a*) Havers Oſteolog. nov. p. 43.
(*b*) Morgagn. Adverſ. 2. animad. 25.

veſſels, makes a bone appear more denſe and compact in the middle of its ſolid ſides, than towards its outer and inner ſurfaces, where it is ſpongy.

We ſee marrow contained in the larger tranſverſe and longitudinal canals juſt now deſcribed, and from thence judge that it paſſes alſo into the ſmaller ones. The drops of oil which we diſcover with a microſcope every where on the ſurface of a recent bone, fractured tranſverſely, and the oozing of oil through the moſt ſolid bones of a ſkeleton, which renders them greaſy and yellow, are a confirmation of the uſe of theſe canals. Of what advantage this diſtribution of the marrow through the ſubſtance of bones is, will be mentioned when the nature and uſe of this animal oil is inquired into.

Moſt bones have one or more large oblique canals formed through their ſides for the paſſage of the medullary veſſels, which are to be deſcribed afterwards.

Bones expoſed to a ſtrong fire in chemical veſſels, are reſolved, in the ſame manner as the other parts of animals, into *phlegm*, *ſpirit*, *volatile ſalt*, *fetid oil*, and a black *caput mortuum*. But the proportion of theſe principles varies according to the age, ſolidities, and other circumſtances of bones. Young bones yield the largeſt proportion of *phlegm*; ſpongy bones afford moſt *oil*, and ſolid ones give moſt ſalt and black *reſiduum*.——Though this *reſiduum* can ſcarce be changed by the force of fire while it is in cloſe veſſels; yet, when it is burnt in an open fire, the tenacious oil, to which it owes its black colour, is forced away, and a white earth is left that has little or no fixed ſalt in it. This earth ſeems to be the proper conſtituent ſolid part of bones, and the other principles give it firmneſs and tenacity: For the quantity of the earth is ſo great, that, after all the other principles are ſeparated from a bone, its former ſhape and ſize remain (*a*); but it is very brittle till it is moiſtened with water or oil, when it recovers ſome tenacity.—The increaſe of the proportion of earth in old people's

(*a*) Havers Oſteolog. nov. diſc. 1. p. 32.

people's bones is one reaſon of their being more brittle than thoſe of young people are.

Leſt any imagine the ſalts and oils of bones, while in a natural ſtate, to be of the ſame acrid kind with thoſe obtained from them by the chemical analyſis, it is to be obſerved, that theſe principles may be extracted from bones in the form of a very mild jelly, by boiling them in water.

The bones ſuſtain and defend the other parts of the body.

Bones are lined within, as well as covered externally, with a membrane; which is therefore commonly called PERIOSTEUM INTERNUM.

The *internal perioſteum* is an extremely fine membrane; nay, frequently it has a looſe reticular texture; and therefore it is compared by ſome to the *arachnoid* coat of the ſpinal marrow: ſo that we cannot expect to divide it into layers as we can divide the *external perioſteum*. We can however obſerve its proceſſes entering into the tranſverſe pores of the bones, where probably they are continued to form the immediate canals for the marrow diſtributed through the ſubſtance of the bones; and along with them veſſels are ſent, as from the external *perioſteum*, into the bone (*b*). Theſe proceſſes being of a very delicate texture, the adheſion of this membrane to the bone is ſo ſmall, that it ſeparates commonly more eaſily from the bone than from the marrow which it contains: Wherefore, one might call it the common membrane of the marrow, rather than by the name it now has. But whether the one or the other deſignation ought to be given it, is not worthy a diſpute.

From the internal ſurface of the internal *perioſteum*, a great number of thin membranes are produced; which, paſſing acroſs the cavity, unite with others of the ſame kind, and form ſo many diſtinct bags, which communicate with each other; and theſe again are ſubdivided into communicating veſicular cells, in which the marrow is contained. Hence it is,

(*b*) Winſlow Expoſition anat. des os frais, § 82. 83.

is, that the marrow, when hardened, and viewed with a microſcope, appears like a cluſter of ſmall pearl; and that the hardened marrow of bones buried long under ground, or laid ſome time in water, and then dried, is granulous (*a*). This texture is much the ſame with what obtains in the other cellular parts of the body, where fat is collected; only that the cells containing the marrow are ſmaller than thoſe of the *tunica adipoſa* or *celluloſa* elſewhere, which probably is owing to their being incloſed in the bones, where they are not ſo much ſtretched or extended as in other parts.

The MARROW is the oily part of the blood, ſeparated by ſmall arteries, and depoſitated in theſe cells. Its colour and conſiſtence may therefore vary according to the ſtate of the veſſels, and their diſtribution on the membranes of the cells.

The marrow, as well as the other fat of the body chemically analyſed, yields, beſides oil and water, a conſiderable proportion of an acid liquor, but no *alcali* (*b*). This may be the reaſon of its being leſs putreſcent than the blood or moſt other parts of animals (*c*), which is a neceſſary quality in a ſubſtance that is conſtantly expoſed to a conſiderable degree of heat, and is more in a ſtagnating condition than the other liquors.

Beſides the arteries, which I mentioned already (p. 7.), to be ſent from the bones to the marrow, there is at leaſt one artery for each bone; ſeveral bones have more, whoſe principal uſe is to convey and ſecern this oily matter. After theſe arteries have pierced the ſolid ſide of a bone, they are divided into ſeveral branches; which ſoon are diſtributed every where on the internal *perioſteum*, and afterwards ſpread their branches inwards on the medullary cells, and outwards through the tables of the bone.

(*a*) Ruyſch. Theſaur. 9. num. 2. et Adverſ. dec. III. obſ. 9.
(*b*) Grutzmaker Diſſert. de oſſium medulla.—Haller Element. phyſiolog. lib. 4. ſect. 4.
(*c*) Pringle Append. to camp diſeaſes, exper. 47.

The blood which remains after the ſecretion of the marrow, is returned by proper veins, which are collected from the membranes into one or two large trunks, to paſs out at the ſame holes or paſſages at which the artery or arteries enter.

The general rule of the ſmall veſſels decreaſing in their capacities as animals advance in age, to which many phænomena in the animal œconomy are owing, obtains here: For though the trunks of the medullary veſſels enlarge as animals turn older; yet the ſmall branches become ſmaller; as is evident from injections, which cannot be made to paſs near ſo far in theſe veſſels of adults as of children. Hence the marrow is bloody in children, oily and balmy in middle age, and thin and watery in old people.

By experiments made on the marrow, when bones of living animals are opened or cut through (*a*), and from the racking pain with which ſuppurations within bones are frequently attended, we have ſufficient proof that the membranes here are ſenſible, and conſequently have nerves diſtributed to them. *Hippocrates* (*b*) might therefore ſay juſtly, that a wound penetrating into the cavity of a bone may produce a *delirium*.

The veſſels of the marrow, wrapt up in one common coat from the *perioſteum*, paſs through the bones by proper canals; the moſt conſiderable of which are about the middle of each bone, and are very oblique. Sometimes theſe veſſels continue at a little diſtance in their paſſage when the canal is divided by a ſmall bony partition or two.

From the ſtructure of the contents of the bones, we may judge how theſe parts, as well as others, may be ſubject to oidema, phlegmon, eryſipelas, ſchirrhus, &c. and may thence be led to a cure of each, before the common conſequence, putrefaction, takes place, and frequently occaſions the loſs of the limb, if not of the patient.

The

(*a*) Du Verney Memoires de l'Acad. des ſciences, 1700.
(*b*) Aphoriſm. § 7. aph. 24.

The marrow is of very confiderable ufe to the bones; for, by entering their tranfverfe canals, and paffing from them into the longitudinal ones, it is communicated to all the plates, to foften and connect their fibres, whereby they are preferved from becoming too brittle; as we fee they do in burnt bones, or thofe long expofed to the air; in people labouring under old age, pox, or fcurvy: In all which cafes, the oil is either in too little quantity, or has its natural good qualities changed for worfe ones.

Befides this advantage which the fubftance of bones has from the marrow, their articulations are faid (*a*) to receive no lefs benefit from it: for it is thought that the marrow paffes into the articular cavities, through the holes which are in the bones near the large joints. And, as a proof of this, it is alledged, that butchers, upon feeing the greater or leffer quantity of marrow, in the bones of cows, can tell whether they have travelled far or little before they were flaughtered.

When the marrow, after having ferved the ufes mentioned, is reaffumed into the mafs of blood, (as it is continually, in common with all other fecreted liquors that have not paffages formed for conveying them out of the body), it corrects the too great acrimony communicated to the faline particles of our fluids by their circulation and heat; in the fame manner as lixivial falts are blunted by oil in making foap. Hence, in acute difeafes, the marrow, as well as the other fat of the body, is quickly wafted, but muft be immediately fupplied by liquors from the veffels; feeing the cells within the bones, which have no affiftance to their contraction from the preffure of the atmofphere, cannot collapfe, as the *tela cellularis* under the fkin does, when the liquor in its cells is abforbed; the bones therefore are always full.

Since it is the nature of all oil to become thin and rancid when expofed long to heat, and bones have

 much

(*a*) Joan de Muralto Vade mecum anat. exercit. 5. § 3.—Havers Ofteolog. nov. difc. 3. p. 179.

much oil in their firm hard ſubſtance, we may know why an ungrateful ſmell, and dark coloured thin *ichor*, proceed more from corrupted bones than from other parts of the body; and we can underſtand the reaſon of the changes of colour which bones undergo, according to their different degrees of mortification.— Hence likewiſe we may learn the cauſe of a *ſpina ventoſa*, and of the difficulty of curing all *caries* of bones proceeding from an obſtruction, and conſequent putrefaction of the marrow; and of the quick pulſe, thirſt, and *hectic paroxyſms*, ſo often attending theſe diſeaſes. Theſe *phænomena* alſo teach us the reaſon of the fatal *prognoſis* taken from black fetid urine in fevers.

Though bones ſo far agree in their ſtructure and annexed parts, yet we may obſerve a conſiderable difference among them in their magnitude, figure, ſituation, ſubſtance, connection, uſes, *&c.* From which authors have taken occaſion to diſtinguiſh them into as many claſſes as they could enumerate of theſe different circumſtances. But theſe being obvious to every perſon that looks on bones, I ſhall only mention one of them; which comprehends very near the whole bones of the body, and at the ſame time leads us to examine the moſt conſiderable variety that is to be found in the diſpoſition of their conſtituent parts, and in their uſes. It is this, that ſome bones are *broad* and *flat*, while others are *long* and *round.*

The *broad* bones have thin ſides, by the plates being ſoon and equally ſent off to form the latticework; which therefore is thicker, and nearly of an equal form all through. By this ſtructure, they are well adapted to their uſes, of affording a large enough ſurface for the muſcles to riſe from, and move upon, and of defending ſufficiently the parts which they incloſe.

The *round* bones have thick ſtrong walls in the middle, and become very thin towards their ends, which is owing to very few plates ſeparating at their middle; where, on that account, the *cancelli* are ſo fine and

and ſmall, that they are not taken notice of: But ſuch bones are ſaid to have a large reſervoir of oil in this place. Towards their ends the lattice-work becomes very thick, and rather more complete than in the other ſort of bones.—Theſe round bones having ſtrong forces naturally applied to them, and being otherwiſe expoſed to violent injuries, have need of a cylindrical figure to reſiſt external preſſure, and of a conſiderable quantity of oil to preſerve them from becoming too brittle. Beſides which, they are advantageouſly provided with thick ſides towards their middle, where the greateſt forces are applied to injure them; while their hollowneſs increaſes their diameter, and conſequently their ſtrength to reſiſt forces applied to break them tranſverſely (*a*). Thus, for inſtance, in eſtimating the proportional reſiſtance of two cylindrical bones of unequal diameters, but conſiſting of an equal number of ſimilar fibres uniformly diſpoſed round each, it is plain,

1. That the abſolute force of theſe two bones is equal, becauſe they conſiſt of equal numbers of ſimilar fibres.

2. That the abſolute forces of all the fibres in each bone have the ſame effect in reſiſting any power applied to break them, as if the ſum of all their forces was united in the reſpective centres of the tranſverſe ſections where the fractures are to be made. For, by hypotheſis, the fibres being uniformly diſpoſed in each, there is not any fibre in either bone that has not a correſponding fibre; the ſum of both whoſe diſtances from the axis of revolution (about which all the parts of the bone muſt revolve in breaking), is equal to two ſemidiameters of the bone: Conſequently each fibre, and all the fibres, may be regarded as reſiſting at the diſtance of one ſemidiameter or *radius* from this axis, that is, in the centre.

3. Since the united force of all the fibres is to be regarded as reſiſting at a diſtance from the centre of motion equal to the ſemidiameter, it follows, that

(*a*) Galilei Mechanic. dialog. 2.

the total refiftance of all thefe fibres, or the ftrength of the bone, is proportional to its femidiameter, and confequently to its diameter.

I have here taken for an example one of the moft fimple cafes for calculating the proportional forces of bones. But, was it not too foreign to the prefent defign, it might be univerfally demonftrated, that, of whatever figure bones are, and in whatever manner their fibres are difpofed, their ftrength muft always be in a *ratio*, compounded of the area of their tranfverfe fections, or of their quantity of bony matter, and of the diftance of the centre of gravity of thefe fections from the centre of motion or fulcrum, on which the bone is fuppofed to be broken (*a*).

Since therefore the ftrength of bones depends on their number of fibres, or quantity of matter, and the largenefs of their diameters, one may conclude, that the part of a bone formerly fractured, and reunited by a *callus*, muft be ftronger than it was before the fracture happened; becaufe both thefe advantages are obtained by a *callus;* which is a wife provifion, fince bones are never fet in fuch a good direction as they were naturally of; and then, wherever a *callus* is formed, there is fuch an obftruction of the veffels, that if the bone was again broken in the fame place, the *offific* matter could not fo eafily be conveyed to reunite it. This *callus* may indeed, for want of compreffion, be allowed to form into a fpongy cellular fubftance (*b*); but even in this cafe, the ftrength of the bone is here increafed by one or both the caufes above-mentioned.

Many bones have protuberances, or *proceffes* *, rifing out from them. If a *procefs* ftands out in a roundifh ball, it is called *caput*, or *head*.—If the head is flatted, it obtains the appellation of *condyle*.—A rough unequal protuberance,

(*a*) See the demonftration of this theorem by Dr Porterfield in the Edinburgh Medical effays, vol. I. art. 10.

(*b*) Ruyfch. Thefaur. 8. n. 49. Muf. anat. thec. B. repofit. 2. n. 2.

* Απόφυσεις, ἔκφυσεις, ἐξοχή, προβολὴ, προβλημα, Exceffus, explanatio, tuberculum, gibbus, eminentia, productio, extuberantia, projectura, enafcentia.

protuberance, is called *tuberoſity*.—When a *proceſs* riſes narrow, and then beomes large, the narrow or ſmall part is named *cervix*, or *neck*.—Long ridges of bones, are called *ſpines*.—Such proceſſes as terminate in a ſharp point, have the general name of *coronæ* †, or *coronoid*, beſtowed on them, though moſt of them receive particular names from the reſemblance they have, or are imagined to have, to other ſubſtances, *e. g. maſtoid*, *ſtyloid*, *anchoroid*, *coracoid*, *ſpinal*, &c.—Such proceſſes as form brims of cavities, are called *ſupercilia* (*a*).

Proceſſes ſerve for the advantageous origin and inſertion of muſcles, and render the articulations firm and ſtable.

Before leaving this ſubject, we muſt remark, that much the greater number of what are called proceſſes in adult bones, diſcover themſelves in children to be *epiphyſes*, or diſtinct bones, which are afterwards united to the other parts; ſuch are the *ſtyloid* proceſſes of the temporal bones, proceſſes of the *vertebræ*, *trochanters* of the thigh, &c. However, as I deſign to inſiſt chiefly on the deſcription of the adult ſkeleton, in which the union of theſe parts is ſo intimate, that ſcarce any veſtige remains of their former ſeparation, I ſhall retain the common appellation of *apophyſe*, or proceſs, to all ſuch protuberances; but ſhall remark the principal ones, that have no juſt title to this name, when they occur in the deſcription of particular bones.

On the ſurfaces of a great many of the bones there are cavities, or depreſſions: If theſe are deep, with large brims, authors name them *cotylæ* (*b*).—If they are ſuperficial, they obtain the deſignation of *glenæ*, or *glenoid*. Theſe general *claſſes* are again divided into ſeveral *ſpecies*:—Of which *pits* are ſmall roundiſh channels ſunk perpendicularly into the bone;—*furrows* are long narrow canals, formed in the ſurface;—*nitches*, or *notches*, ſmall breaches in the bone;—*ſinuoſities*,

† Roſtra, glandes.

(*a*) Ἴτυες, ὄφρυες, ἄμβωνες, χεῖλη, Labra.

(*b*) Κοτυλίδες, ὀξυβάφοι, Acetabula, pixides, buccellæ.

ſinuoſities, broad, but ſuperficial depreſſions without brims;—*foſſæ*, large deep cavities, which are not equally ſurrounded by high brims;—*ſinuſes*, large cavities within the ſubſtance of the bones, with ſmall apertures;—*foramina*, or holes, canals that pierce quite through the ſubſtance of the bones.—When this laſt ſort of cavity is extended any long way within a bone, the middle part retains the name of *canal*, and its ends are called *holes*.

The cavities allow the heads of bones to play in them; they lodge and defend other parts; they afford ſafe paſſage to veſſels, muſcles, *&c.* To mention more, would engage us too much in the hiſtory of particular bones, which more properly belongs to the demonſtration of the *ſkeleton*, where we ſhall have occaſion to obſerve theſe ſeveral ſpecies of cavities.

To far the greater number of bones, whoſe ends are not joined to other bones by an immoveable articulation, there are ſmaller ones annexed, which afterwards become ſcarce diſtinguiſhable from the ſubſtance of the bone itſelf. Theſe are called *epiphyſes*, or *appendices* (*c*). Some bones have one, others have two, three, or four of theſe *appendices* annexed, by the means of cartilages, which are of a conſiderable thickneſs in children, but by age become thinner; the oſſification proceeding from the end of the bone on one ſide, and from the *epiphyſes* on the other, till at laſt, in adults, the place of their conjunction can ſcarcely be ſeen on the external ſurface; and it is only ſometimes that we can then ſee any mark of diſtinction in the *cancelli* (*d*).

Several proceſſes (*e. g. trochanters* of the thigh, *ſpine* of the *ſcapula*, *&c.*) have *epiphyſes*; and proceſſes frequently riſe out from *epiphyſes*; for example, at the lower end of the *femur*, *ulna*, *tibia*, *&c.* (*e*).

The *epiphyſes* are united chiefly to ſuch bones as are deſtined for frequent and violent motion; and for this

(*c*) Applantatio, additamentum, adnaſcentia, adnexum, perone.

(*d*) Winſlow Expoſition anatomique de corps humain, traité des os ſecs, § 116.

(*e*) Veſal. De human. corp. fabrica, lib. 1. cap. 3.

this purpoſe they are wiſely framed of a larger diameter than the bone they belong to; for by this means, the ſurface of contact between the two bones of any articulation being increaſed, their conjunction becomes firmer, and the muſcles inſerted into them act with greater force, by reaſon of their axes being further removed from the centre of motion. Theſe advantages might indeed have been obtained by the expanſion of the end of the bone itſelf, to a thickneſs equal to that of the *epiphyſes;* but then the conſtant ſeparation of new plates to form ſo wide a cellular ſtructure, muſt have left the ſolid ſides of the bones ſo thin, as to yield eaſily, either to the action of the muſcles fixed to them, and paſſing over them, to the weight ſeveral of them are obliged to ſupport, or to the application of any other external force.

Several anatomiſts (*f*) thought that the *epiphyſes* ſerve other purpoſes: ſuch as, ſecuring the ligaments of the articulations which riſe out from between the bones and them; for, as ſoon as theſe parts are intimately joined, the ligaments inſinuated betwixt them muſt have a much ſtronger connection than they could have to the ſmooth ſurface of the bones. Such an interception of the ligament between the body of the bone and its *epiphyſe* is not to be ſeen; but as, at this place, the bone remains longer ſoft than any where elſe, and the adheſion of the *perioſteum*, and of ligaments to bones, is always ſtronger in proportion to the bones being neareſt to the conſiſtence of thoſe parts, which is, being ſofteſt, the opinion of theſe writers concerning the ſtronger connection of the ligaments, where the bones and *epiphyſes* join, is not without ſome foundation.

Poſſibly, too, by the fibres of *epiphyſes* not extending themſelves ſo longitudinally as thoſe of the bones, there may be leſs chance of the former running into each other, than of the latter.

The

(*f*) Collumb. De re anatomica, lib. 1. cap. 2.—Fallop. Expoſ. de oſſibus, cap. 11.

The ſoftneſs of the ends of bones may be of ſome advantage in the womb, and at birth, after which the oſſification begins at different points to form *epiphyſes*, before the oſſification can extend from the middle to the ends of the bones (*g*).

However ſolid and compact adult bones are, yet they were once cartilages, membranes, nay, a mere jelly. This needs no further proof, than repeated obſervations of *embryos* when diſſected: And how much more tender muſt the bones be before that time, when neither knife nor eye is capable to diſcover the leaſt rudiments of them? By degrees they become more ſolid, then aſſume the nature of griſtles, and at laſt oſſify; the coheſion of their plates and fibres always increaſing in proportion to their increaſed ſolidities; as is evident from the time neceſſary to unravel the texture of bones of people of different ages, or of denſe and of ſpongy bones, or of the different parts of the ſame bone, and from the more tedious exfoliations of the bones of adults than of children.

After any part of a bone is fully oſſified, its fibres are extended little more in length at that part, though they increaſe there in thickneſs, and though their ſofter parts continue to become longer (*h*).

As the ſolidity of bones increaſes, their *perioſteum* more eaſily ſeparates from them. When bones are membranous, the *perioſteum* and they cannot be diſtinguiſhed; they appear to be the ſame ſubſtance. When they are cartilages, their membrane adhere ſo firmly to them, that it is difficult to ſeparate it from them. Where the rigid bony fibres are, the *perioſteum* is eaſily taken off. Is the ſimilarity of ſtructure and conſequent greater attraction of the membrane and ſubſtance it incloſes, while they are both flexible, the cauſe of their greater adheſion? or is it owing to the veſſels that go from the one to the other being

(*g*) Haller de ſtudio medic. p. 267.

(*h*) Hales's Vegetable ſtatics, p. 293.—Du Hamel Memoires de l'acad. des ſciences, 1742.

ing then larger? or do both these causes combine to produce this effect? Or is the membrane or cartilage, which becomes bone afterwards, to be considered as the same substance with the *periosteum* (*i*)? and must all these plates of bones be therefore said to be layers of the *periosteum* hardened (*k*)?

The ossification of bones depends principally on their vessels being so disposed, and of such diameters, as to separate a liquor, which may easily turn into a bony substance, when it is deprived of its thinner parts; as seems plain from the observation of the callous matter separated after fractures and ulcers, where part of the bone is taken out: For in these cases, the vessels extending themselves, and the liquors added to them, are gradually formed into granulated flesh; which fills up all the space where the bone is taken from, then hardens, till it becomes as firm as any other part of the bone. This happens frequently, even when the ends of the diseased bone are at a considerable distance from each other (*l*).

The induration of bones is also greatly assisted by their being exposed, more than any other parts, to the strong pressure of the great weights they support, to the violent contraction of the muscles fixed to them, and to the force of the parts they contain, which endeavour to make way for their own further growth. By all this pressing force, the solid fibres and vessels of bones are thrust closer; and such particles of the fluids conveyed in these vessels as are fit to be united to the fibres, are sooner and more firmly incorporated with them, while the remaining fluids are forcibly driven out by the veins, to be mixed with the mass of blood. In consequence of this, the vessels gradually diminish as the bones harden. From which again we can understand one reason, why the bones of young animals sooner reunite after a fracture than those

(*i*) Memoires de l'acad. des sciences, 1744.

(*k*) Memoires de l'acad. des sciences, 1743.

(*l*) Hildan. de vuln. gravis.—Med. essays, vol. I. art. 23.—Job à Meckren obs. 69.—Mem. de l'acad. des sciences, 1742.—See a collection of such cases in Boehmer de ossium callo.

thofe of old, and why cattle that are put too foon to hard labour feldom are of fuch large fize as others of the fame brood who are longer kept from labour.

That the offifying of bones greatly depends on preffure, feems to be evinced from the frequent examples we meet with of other parts turning bony, when long expofed to the preffing force of the furrounding parts, or when they are fubjected to the like circumftances by their own frequent and violent contraction. Witnefs, the bones found frequently near the bafe of the heart in fome old men (*m*), and in feveral other creatures. Nay, the mufcular fubftance of the heart has been offified in fuch (*n*), and the arteries of old men often become bony.—The cartilages of the *larynx* are generally offified in adults.—In beafts of burden, the cartilages between the *vertebræ* of the back very often change into complete bones; and, being intimately united with the *vertebræ*, the whole appears one continued bone:—Nor is the *periofteum* exempted from fuch an induration (*o*).

To confirm this argument ftill farther, we may obferve, that bones begin their offification at the places where they are moft expofed to thefe caufes, *viz.* in the cylindrical bones from a middle ring, and in the broad ones, at or near their centre, from one or more diftinct points. The reafon of which is, that thefe parts are contiguous to the bellies of the mufcles annexed to the bones, where the fwelling of thefe moving powers is greateft. What the effects of this may be, let any judge, who view fome of the bones, as the *fcapula*, and *offa ilium*, which are covered with mufcles on each fide; how compact and thin they are in adults, where the bellies of the mufcles were lodged; whereas in children they are thicker. But this being the middle part of thefe bones,

(*m*) Riolan. Comment. de offib. cap. 32.—Bartholin. Hift. med. cent. 1. hift. 50.—Ibid. cent. 2. hift. 45.

(*n*) Chefelden's Anatomy, book 1. introd.—Garengeot Hift. de l'acad. des fciences, 1726.

(*o*) Peyer. Ephemerid. German. decur. 2. ann. 7. obferv. 205.

bones, where the greateſt number of fibres is, this particular place would have been much thicker in adults, had not this forcible cauſe been applied, which has not had ſuch effects in children, whoſe muſcles have not been much exerciſed.—Beſides, if we allow that all the parts of a bone are equally increaſed by the conſtant ſupply of new particles, each fibre, and every particle of a fibre, endeavours to make way for its own growth, by puſhing the one next to it; and conſequently by far the greateſt preſſure is on the middle, to make the particles firm, and therefore to begin their oſſification there. *Laſtly*, The pulſation of the medullary arteries, which enter the bones near to this middle part, may, as authors have alledged, contribute perhaps ſomewhat to this induration.

From the effects of preſſure only it is, that we can account for the bones of old people having their ſides much thinner, yet more denſe and ſolid, while the cavities are much larger than in thoſe of young people; and for the prints of muſcles, veſſels, *&c.* being ſo much more ſtrongly marked on the ſurfaces of the former than of the latter, if they belong to people of near the ſame condition in life.—Preſſure muſt likewiſe be the cauſe which, in people of equal ages, makes theſe prints ſtronger in the bones of thoſe who had much labour and exerciſe, than they are in people who have led an indolent inactive life.

Perhaps both the cauſes of oſſification above mentioned, may be aſſiſted by the nature of the climate people live in, and the food they uſe. Whence, in hot countries, the inhabitants ſooner come to their height of ſtature than in the northerly cold regions: And thence ſeems to have ariſen the common practice among the ladies, of making puppies drink brandy or ſpirit of wine, and of bathing them in theſe liquors, to prevent their growing big. Nay, it has been obſerved, that much uſe of ſuch ſpirits has occaſioned parts, naturally ſoft, to petrify in ſome, and to oſſify in other people of no great age (*p*).

(*p*) Littre Hiſtoire de l'acad. des ſciences, 1706.—Geoffroy Memoires de l'acad. des ſciences, 1706.

From the foregoing account of the ſtructure of bones, and of their oſſification, we may underſtand the reaſons of the following phænomena.

How the natural colour of bones may be changed by ſome ſorts of food (*q*).

Why the bones of ſome people are ſo long in hardening, and in others never completely indurate.

Why, in ſuch whoſe oſſification is ſlow, the bones are generally thicker in proportion to their lengths, eſpecially at their ends; as in the *rickets*.

How hard firm bones have become ſoft and pliable by diſeaſes (*r*).

Why in ſome diſeaſes, *epiphyſes* ſeparate from bones (*s*), and the ends of fractured bones come aſunder many years after their fractures appeared to be cured (*t*).

How bones may waſte and diminiſh (*u*).

How bones may become ſolid all through, without any appearance of *cancelli* (*x*).

How *nodes*, *tophi*, and *exoſtoſes*, happen after the eroſion of the external plates of bones in the *lues venerea*, *ſcurvy*, *rheumatiſm*, and *gout*.

How bones exfoliate by the riſing of granulated fleſh from their ſurface.

How, and from what *callus* is formed after a fracture (*y*).

Why

(*q*) Philoſoph. Tranſact. Num. 442. art. 8. Num. 443. art. 2. Num. 457. art. 4.—Mem. de l'acad. des ſciences, 1739, 1742.

(*r*) Hiſtoire de l'acad. des ſciences, 1700.—Mem. 1722.—Gagliardi Anat. oſſium, cap. 2. obſerv. 3.—Ephem. Germ. decur. 1. ann. 1. obſ. 37. et ſchol. decur. 2. ann. 7. obſ. 212, 235. decur. 3. ann. 2. obſ. 3.—Philoſ. Tranſ. Num. 470. § 3.—Ibid. vol. 40. § 4. and 44.

(*s*) Memoires de l'acad. des ſciences, 1699.—Diemerbroek Anat. lib. 9. cap. 19.—Cowper's Anat. explic. tab. 96. fig. 1.

(*t*) Anſon's Voyage.

(*u*) Cheſelden's Anat. book 1. introd.—Hiſt. de l'acad. des ſciences, 1700.

(*x*) Ruyſch. Theſaur. 2. arc. 5. theſ. 3. loc. 1. Num. 5. theſ. 9. Num. 2. not. 3.—Boehmer de callo oſſium.

(*y*) Memoires de l'acad. des ſciences, 1741.—Dehtleef de oſſium callo.

Why *callus* appears to be rather the continued ſubſtance of the *perioſteum* than of the bone, while it remains ſoft and flexible; but ſeems continued with the bone after it oſſifies (z).

Why *callus* is ſenſible, while it is ſoft, but becomes inſenſible when it hardens.

What occaſions ſometimes ſuch difficulty in curing fractured bones; or why they never reunite, though they are reduced, and all proper means towards a cure are uſed (*a*).—Are the bones of women with child more tedious in reuniting than thoſe of other people (*b*)?

Why *calluſes*, after fractures, are ſometimes very thick and protuberant.

What difference there ought to be in the application of bandages to fractures of the bones of old and of young patients.

How bones, remaining long unreduced after a luxation, may have their form ſo changed as to make their reduction very difficult, if not impoſſible (*c*).

Whoever is deſirous to know, in what time and order each bone and its ſeveral parts begin to aſſume a bony nature, let him conſult *Kerckingius* (*d*), who gives us the delineations of abortions from three days after conception, and traces the oſſification of the bones from three weeks, and a month, till the time of the birth: To whom ſhould be added *Coiterus* (*e*) and *Eyſſonius* (*f*). An account of this ſubject might alſo be collected out of Ruyſch's works, where ſome of the miſtakes committed by the former authors are corrected: And ſeveral more particulars,

(*z*) Mem. de l'acad. 1741.

(*a*) Meckren Obſerv. medico-chirurg. obſ. 71.—Ruyſch. Adverſ. dec. 2. § 2. obſerv. anat. chir. obſ. 4.—Van Swieten in Boerhaave Aphor. § 354.

(*b*) Hildan. centur. 5. obſ. 87. et cent. 6. obſ. 68.—Philoſ. Tranſ. No. 494. § 21.

(*c*) Saltzman. Obſ. decur. obſ. 6.—Memoires de l'acad. de chirur. tom. 2. p. 155.— Boehmer Inſtit. oſteolog. § 596.

(*d*) Anthropograph. ichnograph. et oſteogenea fœtuum.

(*e*) De oſſibus fœtus abortivi.

(*f*) De oſſibus infant. cognoſcend. et curand.

culars, to make the hiſtory of the *oſteogenea* more accurate, have ſince been added by *Neſbit* (g) and *Albinus* (h).

I muſt refer to the authors now quoted for the more curious part of the human oſteogeny; not having preparations enough to give ſuch a full hiſtory of it as is done by them. But I ſhall endeavour to explain the more uſeful and neceſſary part of the oſteogeny, by ſubjoining to the deſcription of each bone of an adult, its condition in ripe children; that is, in ſuch as are born at the ordinary time; and ſhall point out what parts of each are afterwards joined in form of *epiphyſes*. This, with the following general rules, ſeem to me ſufficient for underſtanding what of this ſubject is neceſſary in the practice of phyſic and ſurgery.

1. Wherever I mention any parts being cartilaginous, or their being ſtill ſeparable from the other parts of the bone to which they belong, I would be underſtood to hint, that, about ſeven or eight years of age, ſuch parts are oſſified and united to their proper bones, unleſs when it is ſaid, that they are afterwards formed into *epiphyſes*.

2. Such as become *epiphyſes*, are generally oſſified at ſeven or eight years of age; but, being for the moſt part moiſtened by *ſynovia*, their external ſurface is ſtill ſomewhat cartilaginous, and they are not yet united to their bones.

3. At eighteen or twenty years of age the *epiphyſes* are entirely oſſified, and have blended their fibres ſo with the body of the bone, as to make them inſeparable without violence.

The knowledge of this part of the *oſteogeny* I think neceſſary, to prevent dangerous miſtakes in the cure of ſeveral diſeaſes. As for example: Without this knowledge, the ſeparation of an *epiphyſe* might be miſtaken for a fracture or luxation.—The interſtice of two parts of a bone not yet joined, might be judged to

(g) Human Oſteogeny explained.

(h) Icones oſſium foetus humani; accedit oſteogeneæ brevis hiſtoria.

to be a fiſſure.—A *diaſtaſis*, or ſeparation of ſuch disjoined pieces of a bone, might be thought a fracture.—The protruſion of one piece, or its overlopping any other, could be miſtaken for an excreſcence or *exoſtoſis*.—Such errors about the nature of a diſeaſe would give one very different indications of cure, from what he would have, if he really underſtood his patient's caſe. And very often the knowledge of the different inequalities on the ſurfaces of bones, muſt direct us in the execution of what is proper to be done to cure ſeveral of their diſeaſes.

Having thus conſidered the bones when ſingle, we ought next to ſhew the different manner of their conjunctions †. To expreſs theſe, anatomiſts have contrived a great number of technical terms; about the meaning, propriety, and claſſing of which, there has unluckily been variety of opinions. Some of theſe terms it is neceſſary to retain, ſince they ſerve to expreſs the various circumſtances of the articulations, and to underſtand the writers on this ſubject.

The ARTICULATIONS are moſt commonly divided into three claſſes, *viz. ſymphyſis*, *ſynarthroſis*, and *diarthroſis*.

Symphyſis, which properly ſignifies the concretion or growing together of parts, when uſed to expreſs the articulations of bones, does not ſeem to comprehend, under the meaning generally given to it, any thing relating to the form or motion of the conjoined bones; but by it moſt authors only denote the bones to be connected by ſome other ſubſtance; and as there are different ſubſtances which ſerve this purpoſe, therefore they divide it into the three following ſpecies:

1. *Synchondroſis* ‡, when a cartilage is the connecting ſubſtance: Thus the ribs are joined to the *ſternum*; thus the bodies of the *vertebræ* are connected to each other; as are likewiſe the *oſſa pubis*.

 2. *Synneuroſis*,

† Σύνταξις, σύνδεσις, συμβολὴ, ὁμιλια, compoſitio, connexio, articulatio, conjunctio, nodus, commiſſura, ſtructura, compages.

‡ Amphiarthroſis.

2. *Synneurosis*, or *syndesmosis*, when ligaments are the connecting bodies, as they are in all the moveable articulations.

3. *Syssarcosis*, when muscles are stretched from one bone to another, as they must be where there are moveable joints.

The *second* class of articulations, the *synarthrosis*, which is said to be the general term by which the immoveable conjunction of bones is expressed, is divided into three kinds.

1. The *suture* † is that articulation where two bones are mutually indented into each other, or as if they were sewed together, and is formed by the fibres of two bones meeting while they are yet flexible and yielding, and have not come to their full extent of growth; so that they mutually force into the interstices of each other, till, meeting with such resistance as they are not able to overcome, they are stopped from sprouting out farther, or are reflected; and therefore these indentations are very different both in figure and magnitude: Thus the bones of the head are joined; thus *epiphyses* are joined to the bones, before their full connection and union with them.

Under this title of *suture*, the *harmonia* of the ancients may be comprehended; scarce any unmoved bones being joined by plain surfaces (*a*).

2. *Gomphosis* ‡ is the fixing one bone into another, as a nail is fixed in a board: Thus the teeth are secured in their sockets.

3. *Shindylesis* or *ploughing* (*d*), when a thin *lamella* of one bone is received into a long narrow furrow of another: Thus the *processus azygos* of the *sphenoid*, and the nasal process of the *ethmoid* bone, are received by the *vomer*.

The *third* class, or *diarthrosis* (*b*), is the articulation where the bones are so loosely connected as to allow

† Ῥαφη.
(*a*) Vesal. Observ. Fallop. Examen.
‡ Conclavatio.
(*d*) Keil Anat. chap. 5. sect. 3.
(*b*) Ἀπαρθρωσις, dearticulatio, abarticulatio.

low large motion. This is ſubdivided into three kinds.

The firſt is *enarthroſis*, or the ball and ſocket, when a large head is received into a deep cavity; as the head of the *os femoris* is into the *acetabulum coxendicis*.

The ſecond is *arthrodia*, when a round head is received into a ſuperficial cavity; as in the articulation of the arm-bone and *ſcapula*. These two ſpecies of *diarthroſis* allow motion to all ſides.

The third is *ginglimus* (*c*), which properly ſignifies the hinge of a door or window; in it the parts of the bones mutually receive and are received, and allow of motion two ways: Workmen call it *charnal*.

The *ginglimus* is generally divided into three kinds, to which ſome (*d*) give the names of *contiguous* (*e*), *diſtant* (*f*), and *compound* (*g*).

The firſt kind of *ginglimus* is, when a bone has ſeveral protuberances and cavities, which anſwer to as many cavities and proceſſes of the other bone, with which it is articulated: as in the conjunction of the *femur* with the *tibia*.

The ſecond ſpecies is, when a bone receives another at one end, and is received by the ſame bone at the other end; as in the *radius* and *ulna*.

The laſt ſort is, when a bone receives another, and is received by a third; as in the oblique proceſſes of the *vertebræ*.

When I firſt mentioned the articulations of bones, I ſaid there were different opinions concerning the uſe of their technical names; *e. g.* It has been ſaid, that *ſymphyſis* ſhould be the name for the immoveable articulations, and *ſynarthroſis* ſhould be underſtood to be the conjunction of bones by ſome connecting *medium*—Thoſe who have taken *ſymphyſis* in the ſenſe I did, of its expreſſing the conjunction of bones with a connecting ſubſtance, have diſagreed in their definition of it; ſome inſerting, and others leaving out, its

(*c*) Articulatio mutua.
(*d*) Baker Curſ. oſteolog. demonſtr. 1.
(*e*) Proximus.
(*f*) Longus.
(*g*) Compoſitus.

its allowing motion.—Where they have agreed in their definition, they have not been of the ſame mind concerning the ſpecies of it. For ſeveral think the *Syſſarcoſis* and *ſyndeſmoſis* applicable to ſo many joints which are univerſally allowed to be claſſed under the *diarthroſis*, that it muſt create confuſion to name them by any ſpecies of the *ſymphyſis*.—Few keep to ſuch a general definition of the *ſynchondroſis* as I have done; and, whether they determine it to allow no motion, or an obſcure or a manifeſt one, bring themſelves into difficulties, becauſe there are examples of all theſe three kinds.—Some again, by too nicely diſtinguiſhing obſcure and manifeſt motions of bones, have blended the *ſynarthroſis* and *diarthroſis*, and from thence have branched out the different compound ſpecies of articulations that may be formed of them, ſo far, that they could find no examples in the body to illuſtrate them by.—It would be tedious to enumerate more of the jarring opinions, and it would be far more ſo to give a detail of the arguments uſed by the diſputants. It is ſufficient for my purpoſe, that it is underſtood in what ſenſe I take theſe technical terms; which I do in the following manner:

When I mention the *ſymphyſis* or *ſynarthroſis*, or any ſpecies of them, I ſhall always underſtand them according to the explication already given of them. But though the preceding account of the *diarthroſis*, or articulation of moveable bones, has been almoſt univerſally received; yet, ſeeing it does not comprehend all the moveable articulations of the body, and one of its ſpecies does not anſwer to any notion we can have of the conjunction of two bones, I muſt beg leave to change the definitions and kinds of theſe joints.

I would call *diarthroſis* that conjunction of bones, whereby they are fitted for motion, being each covered with a ſmooth cartilage, connected by one or more common ligaments, and lubricated with liquor at the conjoined parts. In which definition, I have no regard to the quantity of motion which they really

ly do perform; the motion being often confined or enlarged by ſome other cauſe not immediately depending on the frame of the two ſurfaces of the bones forming the particular joint which then is conſidered.

The firſt ſpecies of the *diarthroſis*, *viz.* the *enarthroſis*, or ball and ſocket, I would define more generally than above, That articulation where a round head of one bone is received into a cavity of another, and conſequently, without ſome foreign impediment, is capable of motion to all ſides. Examples of this kind are to be ſeen in the articulation of the thigh-bone and *oſſa innominata*; arm-bone and *ſcapula*; *aſtragalus* and *os naviculare*; *magnum* of the wriſt, with the *ſcaphoides* and *lunare*; firſt bone of the thumb with the ſecond, *&c.*

The ſecond ſort, or the *arthrodia*, differing from the *enarthroſis*, in the preceding account, only in the cavity's being more ſuperficial, which makes no eſſential difference, eſpecially that, in the recent ſubject, cartilages or ligaments ſupply the deficiency of bone, ought, in my opinion, to be called with *Veſalius* (*a*), that articulation of two bones adapted for motion, where it is not at firſt ſight obvious which of the two has the head or cavity, or where they are joined by plain ſurfaces, or nearly ſo; ſuch is the conjunction of the *clavicle* with the *ſcapula*; *oſſa cuneiformia* with the *os naviculare*; *metatarſal* bones with the *oſſa cuneiformia*, *&c.* From the nature of this ſort of joint, it is plain, that very great motion cannot be allowed, without the bones going farther out of their natural ſituation, than is convenient or ſafe.

Ginglimus, I would reckon that articulation by the form of which the motion of the joined bones muſt be chiefly confined to two directions, which hinges of doors are.

The firſt ſpecies of this is the *trochoides*, when one bone turns on another, as a wheel does on its axis: Thus the firſt *vertebra* of the neck moves on the tooth-

(*a*) De corp. human. fabrica, lib. I. cap. 4.

tooth-like procefs of the fecond. This is the moft proper kind of *ginglimus*.

The fecond fpecies fhould be efteemed that articulation where feveral prominent and hollow furfaces of two bones move on each other, within the fame common ligament; as in the knee, elbow, *&c.*

The third fort of *ginglimus* is, when two bones are articulated to each other at different parts, with a diftinct *apparatus* of the motory machines at each; fuch is the articulation of the *os occipitis* with the firft *vertebra* of the neck; of any two contiguous *vertebræ*, by their oblique proceffes; of the ribs with the bodies and tranfverfe proceffes of the *vertebræ*; of the *radius* with the *ulna*, *tibia* with the *fibula*, *aftragalus* with the *calcaneum*, *&c.*

I would entirely throw out what is commonly called the third kind of *ginglimus*: For, in examining the conjunction of a bone with two others, as in the common example of a *vertebra* joined with the one above and below, the connection of the middle one with each of the other two ought to be confidered feparately; otherwife we might with the fame propriety efteem the articulations that the long bones, the *femur*, *tibia*, *humerus*, *&c.* have at their different ends, as one articulation; which is abfurd.

If the moveable bones are not connected and kept firm by fome ftrong fubftance, they would be luxated at every motion of the joints: and if their hard rough unequal furfaces were to play on each other, their motion would not only be difficult, but the lofs of fubftance from attrition would be great. Therefore *ligaments* are made to obviate the firft, and *cartilages* to prevent the other inconveniency. But becaufe ligaments and cartilages turn rigid, inflexible, and rough, unlefs they are kept moift, a fufficient quantity of proper liquors is fupplied for their lubrication, and to preferve them in a flexible ftate. Seeing then thefe parts are fo neceffary to the articulations, I fhall next confider their ftructure, fituation, and ufes,

ufes, fo far as they are fubfervient to the bones, and their motions.

LIGAMENTS (*a*) are white flexible bodies, thicker and firmer than membranes, and not fo hard or firm as cartilages, without any remarkable cavity in their fubftance, difficultly ftretched, and with little elafticity; ferving to connect one part to another, or to prevent the parts to which they are fixed from being removed out of that fituation which is ufeful and fafe.

After maceration in water, the ligaments can eafily be divided; and each ligamentous layer appears compofed of fibres, the largeft of which are difpofed in a longitudinal direction.

The *arteries* of ligaments are very confpicuous after a tolerable injection, and the larger trunks of their veins are fometimes to be feen full of blood.

Such ligaments as form the fides of cavities, have numerous orifices of their arteries opening upon their internal furface, which keep it always moift: If we rub off that moifture, and then prefs the ligament, we can fee the liquor oozing out from fmall pores; and we can force thin liquors injected by the arteries into the cavities formed by ligaments.

Thefe exhalent arteries muft have correfponding abforbent *veins*, otherwife the cavities would foon be too full of liquor.

Ligaments then muft be fubject to the difeafes common to other parts, where there is a circulation of fluids, allowance always being made for the fize of veffels, nature of the fluids, and firmnefs of the texture of each part.

Authors generally fay, that ligaments are infenfible: and confequently it may be inferred, that they have no nerves beftowed on them. But the violent racking pain felt on the leaft motion of a joint labouring under a *rheumatifm*, the feat of which difeafe feems often to be in the ligaments, and the infufferable torture occafioned by incifions of ligaments, and by a col-

(*a*) Σύνδεσμοί, νεῦροι, copulæ, vincula.

a collection of acrid matter in a joint, or by *tophi* in the gout, would persuade us, that they are abundantly supplied with nerves.

The ligaments which connect the moveable bones commonly rise from the conjunction of the *epiphysis* of the one bone, and are inserted into the same place of the other; or where *epiphyses* are not, they come out from the *cervix*, and beyond the *supercilia* of the articulated bones; and after such a manner, in both cases, as to include the articulation in a purse or bag, with this difference, depending on their different motions, that where the motion is only to be in two directions, the ligaments are strongest on those sides towards which the bones are not moved; and when a great variety of motions is designed to be allowed, the ligaments are weaker than in the former sort of articulations, and are nearly of the same strength all round.

Part of the capsular ligaments is composed of the *periosteum*, continued from one bone to another, as was observed *p.* 2. and their internal layer is continued on the parts of the bone or cartilage which the ligament includes (*a*).

Besides these common capsular ligaments of the joints, there are particular ones in several places, either for the firmer connection of the articulated bones, or for restraining and confining the motion to some one side; such are the *cross* and *lateral* ligaments of the knee, the *round* one of the thigh, &c.

From this account of the ligaments, we may conclude, that, *cæteris paribus*, in whatever articulation the ligaments are few, long, and weak, the motion is more free and quick; but luxations happen frequently: And, on the contrary, where the ligaments are numerous, short, and strong, the motion is more confined; but such a joint is less exposed to luxations (*b*).—Whence we may judge how necessary it is to attend to the different ligaments, and the changes which

(*a*) Nesbit Osteogen.—Philos. transact. No. 470. sect 6.
(*b*) Fabric. ab. Aquapend. de articul. part. utilit. pars 3.

which have been made on them by a luxation, when it is to be reduced.

Ligaments alſo ſupply the place of bones in ſeveral caſes to advantage: Thus the parts in the *pelvis* are more ſafely ſupported below by ligaments than they could have been by bone.—The ligaments placed in the great holes of the *oſſa innominata*, and between the bones of the fore-arm and leg, afford convenient origin to muſcles.—Immoveable bones are firmly connected by them; of which the conjunction of the *os ſacrum* and *innominatum* is an example.—They afford a ſocket for moveable bones to play in, as we ſee part of the *aſtragalus* does on the ligament ſtretched from the heel-bone to the *ſcaphoid*.

Numerous inconveniencies may ariſe from too long or ſhort, ſtrong or weak, lax or rigid ligaments.

CARTILAGES * are ſolid, ſmooth, white, elaſtic ſubſtances, between the hardneſs of bones and ligaments, and covered with a membrane, named *perichondrium*, which is of the ſame ſtructure and uſe to them as the *perioſteum* is to the bones.

Cartilages are compoſed of plates, which are formed of fibres, diſpoſed much in the ſame way as thoſe of bones are; as might be reaſonably concluded from obſerving bones in a cartilaginous ſtate before they oſſify, and from ſeeing, on the other hand, ſo many cartilages become bony. This may be ſtill further confirmed by the *exfoliation* which cartilages are ſubject to as well as bones.

The *perichondrium* of ſeveral cartilages, for example, thoſe of the ribs and *larynx*, has arteries which can be equally well injected with thoſe of the *perioſteum*; but the veſſels of that membrane in other parts, *e. g.* the articular cartilages, are ſmaller, and in none of them does injection enter deep into the ſubſtance of the cartilages; nay, madder, mixed with the food of animals, does not change the colour of cartilages as it does that of bones (*a*).

* Χονδροι.

(*a*) Philoſ. Tranſact. No. 442. art. 8. No. 443. art. 2. No. 457 art. 4.—Mem. de l'acad. des ſciences, 1739 et 1742.—Dehtleef de oſſium callo.

The granulated flefh which rifes from the ends of metacarpal or metatarfal bones, when the cartilage exfoliates, after a finger or toe has been taken off at the firft joint, is very fenfible, from which the exiftence of nerves in cartilages may be inferred.

While cartilages are in a natural ftate, it is to be remarked, *firft*, That they have no cavity in their middle for marrow. *Secondly*, That their outer furface is fofteft, which renders them more flexible. *Thirdly*, That they do not appear to change their texture near fo much by acids as bones do. And, *laftly*, That as the fpecific gravity of cartilages is near a third lefs than that of bones; fo the cohefion of their feveral plates is not fo ftrong as in bones; whence cartilages laid bare in wounds or ulcers, are not only more liable to corrupt, but exfoliate much fooner than bones do.

Cartilages feem to be principally kept from offifying, either by being fubjected to alternate motions of flexion and extenfion, the effects of which are very different from any kind of fimple preffure, or by being conftantly moiftened (*a*): Thus, the cartilages on the articulated ends of the great bones of the limbs, and the moveable ones placed between the moving bones in fome articulations, which are obliged to fuffer many and different flexions, and are plentifully moiftened, fcarce ever change into bone; while thofe of the ribs and larynx are often offified.—The middle angular part of the cartilages of the ribs, which is conftantly in an alternate ftate of flexion and extenfion, by being moved in refpiration, is always the laft of becoming bony.—In the *larynx*, the *epiglottis*, which is oftener bended and more moiftened than the other four cartilages, feldom is offified, while the others as feldom efcape it in adults.

The cartilages fubfervient to bones, are fometimes found on the ends of bones which are joined to no other; but are never wanting on the ends, and in the cavities of fuch bones as are defigned for motion (*b*).

Cartilages

(*a*) Havers Ofteolog. nov.
(*b*) Celf. de re medic. lib. 8. cap. 1.

Cartilages alſo are interpoſed between ſuch other cartilages as cover the heads and cavities of articulated bones; nay, they are alſo placed between immoveable bones.

The uſes of cartilages, ſo far as they regard bones, are, to allow, by their ſmoothneſs, ſuch bones as are deſigned for motion, to ſlide eaſily without detrition, while, by their flexibility, they accommodate themſelves to the ſeveral figures neceſſary in different motions, and, by their elaſticity, they recover their natural poſition and ſhape as ſoon as the preſſure is removed.—This ſpringy force may alſo aſſiſt the motion of the joint to be more expeditious, and may render ſhocks in running, jumping, &c. leſs.—To theſe cartilages we chiefly owe the ſecurity of the moveable articulations: For without them, the bony fibres would ſprout out, and intimately coaleſce with the adjoining bone; whence a true *anchyloſis* muſt neceſſarily follow; which never fails to happen when the cartilages are eroded by acrid matter, or oſſified from want of motion or defect of liquor, as we ſee often happens after wounds of the joints, *paidarthrocace*, *ſcrophula*, and *ſpina ventoſa*, or from old age, and long immobility of joints (*a*).—Hence we may know what the annihilation is which is ſaid to be made of the head of a bone, and of the cavity for lodging it, after an unreduced fracture (*b*). The moveable cartilages interpoſed in joints, ſerve to make the motions both freer and more ſafe than they would otherwiſe be.—Thoſe placed on the ends of bones that are not articulated, as on the *ſpine* of the *os ilium*, baſe of the *ſcapula*, &c. ſerve to prevent the bony fibres from growing out too far.—Cartilages ſometimes ſerve as ligaments, either to faſten together bones that are immoveably joined, ſuch are the cartilages between the *os ſacrum* and *oſſa ilium*, the *oſſa pubis*, &c. or to

 connect

(*a*) Columb. de re anat. lib. 15.—Deſiandes Hiſt. de l'acad. des ſciences, 1716.—Phil. tranſact. No. 215.—Ibid. No. 461. § 16.

(*b*) Hildan. de ichor. et melicer. acri Celſi, cap. 5.—Ruyſch. Theſ. 8. No. 103.—Saltzman in act. Petropolit. tom. 3. p. 275.

connect bones that enjoy manifest motion, as those do which are placed between the bodies of the true *vertebræ*, &c.—Cartilages very often do the office of bones to greater advantage than these last could, as in the cartilages of the ribs, those which supply brims to cavities, &c.

Too great thickness or thinness, length or shortness, hardness or suppleness of cartilages, may therefore cause great disorders in the body.

The liquor, which principally serves to moisten the ligaments and cartilages of the articulations, is supplied by glands, which are commonly situated in the joint, after such a manner as to be gently pressed, but not destroyed by its motion. By this means, when there is the greatest necessity for this liquor, that is, when the most frequent motions are performed, the greatest quantity of it must be separated. These glands are soft and pappy, but not friable: In some of the large joints they are of the conglomerate kind, or a great number of small glandules are wrapt up in one common membrane. Their excretory ducts are long, and hang loose, like so many fringes, within the articulation; which, by its motion and pressure, prevents obstructions in the body of the gland or its excretories, and promotes the return of this liquor, when fit to be taken up by the absorbent vessels, which must be in the joints, as well as in the other cavities of the body; and, at the same time, the pressure on the excretory ducts hinders a superfluous unnecessary secretion, while the fimbriated disposition of these excretories does not allow any of the secreted liquor to be pushed back again by these canals towards the glands (*c*).

Very often these fountains of slimy liquor appear only as a net-work of vessels.—Frequently they are almost concealed by cellular membranes containing the fat—and sometimes small simple mucous *folliculi* may be seen (*d*).

The

(*c*) Cowper Anat. explicat. tab. 79. lit. E. E.

(*d*) Morgagn. Adversar. 2. animad. 23.

The different joints have these organs in different numbers and sizes; the conglomerate ones do not vary much, especially as to situation, in the similar joints of different bodies; but the others are more uncertain.

Upon pressing any of these glands with the finger, one can squeeze out of their excretories a mucilaginous liquor, which somewhat resembles the white of on egg, or *serum* of the blood; but it is manifestly salt to the taste. It does not coagulate by acids, or by heat, as the *serum* does, but by the latter turns first thinner, and, when evaporated, leaves only a thin salt film.

The quantity of this *mucilage* constantly supplied, must be very considerable, since we see what a plentiful troublesome discharge of glary matter follows a wound or ulcer of any joint; of which liquor the mucilage is a considerable part.

The vessels which supply liquors for making the secretion of this mucilage, and the veins which bring back the blood remaining after the secretion, are to be seen without any preparation; and, after a tolerable injection of the arteries, the glands are covered with them.

In a sound state, we are not conscious of any sensibility in those glands; but, in some cases which I have seen, when they inflame and suppurate, the most racking pain is felt in them: a melancholy, though a sure proof that they have nerves.

These mucilaginous glands are commonly lodged in a cellular substance; which is also to be observed in other parts of the bag formed by the ligaments of the articulation; and contains a fatty matter, that must necessarily be attenuated, and forced through the including membranes into the cavity of the joint, by the pressure which it suffers from the moving bones.

If then the oil is conveyed from this cellular substance; and if the attenuated marrow passes from the *cancelli* of the bones by the large pores near their

 ends,

ends, or in their cavities, and ſweats through the cartilages there into the articulations; which it may, when aſſiſted by the conſtant heat and action of the body, more eaſily do, than when it eſcapes through the compact ſubſtance of the bones in a ſkeleton: If, I ſay, this oil is ſent to a joint, and is incorporated with the mucilage, and with the fine lymph that is conſtantly oozing out at the extremities of the ſmall arteries diſtributed to the ligaments, one of the fitteſt *liniments* imaginable muſt be produced; for the *mucus* diluted by the lymph, contributes greatly to its lubricity, and the oil preſerves it from hardening. How well ſuch a mixture ſerves the purpoſe it is deſigned for, *Boyle* (*e*) tells us he experienced in working his air-pump; for the ſucker could be moved with much leſs force after being moiſtened with water and oil, than when he uſed either one or other of theſe liquors: And I believe every one, at firſt view, will allow the diluted mucilage to be much preferable to ſimple water. The *ſynovia (f)*, as this liquor compoſed of oil, mucilage, and lymph, is commonly now called, while in a ſound ſtate, effectually preſerves all the parts concerned in the articulations ſoft and flexible, and makes them ſlide eaſily on each other, by which their mutual detrition and overheating is prevented, in the manner daily practiſed in coach and cart wheels, by beſmearing them with greaſe and tar.

After the liquor of the articulations becomes too thin and unſerviceable, by being conſtantly pounded and rubbed between the moving bones, it is reaſſumed into the maſs of blood by the abſorbent veſſels.

When the *ſynovia* is not rubbed betwixt the bones, it inſpiſſates. And ſometimes, when the head of a bone has been long out of its cavity, this liquor is ſaid to fill up the place of the bone, and hinder its reduction; or if a joint continues long unmoved, it is alſo ſaid to cement the bones, and occaſion a true *anchyloſis*;

(*e*) Phyſico-mechanic. experim.

(*f*) Μύζα, mucus, axungia.

anchylosis (g).—If the *synovia* becomes too acrid, it erodes the cartilages and bones; as frequently happens to those who labour under the *lues venerea*, *scurvy*, *scrophula*, or *spina ventosa*.—If this liquor is separated in too small quantity, the joint becomes stiff; and when with difficulty it is moved, a crackling noise is heard, as people advanced in years frequently experience (h).—If the mucilage and lymph are deposited in too great quantity, and the absorbent vessels do not perform their office sufficiently, they may occasion a dropsy of the joints (i).—From this same cause also the ligaments are often so much relaxed, as to make the conjunction of the bones very weak: Thence arise the luxations from an internal cause, which are easily reduced, but difficultly cured (k).—Frequently, when such a superfluous quantity of this liquor is pent up, it becomes very acrid, and occasions a great train of bad symptoms; such as swelling and pain of the joints, long sinuous ulcers, and *fistulæ*, rotten bones, immobility of the joints, *marcor* and *atrophia* of the whole body, hectic fevers, &c. (l).—From a depravity in the blood, or diseases in the organs that furnish the *synovia* of the joints, it may be greatly changed from its natural state; it may be purulent after inflammation, mucous in the white swelling, gelatinous in the rheumatism, chalky from the gout, &c.; hence a great variety of disorders in the joints (m).

THE

(g) Pare Chirurgie, livre 15. chap. 18. et livre 16. chap. 5.

(h) Galen de usu part. lib. 12. cap. 2.—Fabric. ab Aquapend. de articul. part. utilitat. pars 3.—Bartholin. Hist. medic. cent. 3. hist. 11.

(i) Hildan. de ichore et meliceria acri Celsi.

(k) Hippocrat. de locis in homine, § 14. et de articul.

(l) Hildan. de ichore et meliceria acri Celsi.

(m) See Reimar. Dissert. de fungo articulor.

THE ANATOMY OF THE HUMAN BONES.

PART II.

Of the SKELETON.

THOUGH any dry ſubſtance may be called *ſkeleton*, yet, among anatomiſts, this word is univerſally underſtood to ſignify the bones of animals connected together, after the teguments, muſcles, bowels, glands, nerves, and veſſels are taken away (*a*).

A ſkeleton is ſaid to be a *natural* one, when the bones are kept together by their own ligaments; and it is called *artificial*, when the bones are joined with wire, or any other ſubſtance which is not part of the creature to which they belonged. Small ſubjects, and ſuch whoſe bones are not fully oſſified, are commonly prepared the firſt way; becauſe, were all their parts divided, the niceſt artiſt could not rejoin them, by reaſon of their ſmallneſs, and of the ſeparation of their unoſſified parts; whereas the bones of large adult animals are ſooneſt and moſt conveniently cleaned when ſingle, and are eaſily reſtored to, and kept in their natural ſituation.—Sometimes the ſkeleton of

(*a*) Cadaveris crates.

of the ſame animal is prepared in both theſe ways; that is, the ſmaller bones are kept together by their natural ligaments, and the larger ones are connected by wires, or ſome ſuch ſubſtances.

Before we proceed to the diviſion and particular deſcription of the ſkeleton, it is worth while to remark, that when the bones are put into their natural ſituation, ſcarce any of them is placed in a perpendicular bearing to another; though the fabric compoſed of them is ſo contrived, that, in an erect poſture, a perpendicular line, from their common centre of gravity, falls in the middle of their common baſe (*b*). On this account, we can ſupport ourſelves as firmly, as if the axis of all the bones had been a ſtraight line perpendicular to the horizon; and we have much greater quickneſs, eaſe, and ſtrength, in ſeveral of the moſt neceſſary motions we perform. It is true, indeed, that where-ever the bones, on which any part of our body is ſuſtained, decline from a ſtraight line, the force required in the muſcles, to counteract the gravity of that part, is greater than otherwiſe it needed to have been: But then this is effectually provided for in ſuch places by the number and ſtrength of the muſcles. So long therefore as we remain in the ſame poſture, a conſiderable number of muſcles muſt be in a conſtant ſtate of contraction; which, we know, both from reaſon and experience, muſt ſoon create an uneaſy ſenſation. This we call, being weary of one poſture: An inconvenience that we ſhould not have had in ſtanding erect, if the bearing of all the bones to each other had been perpendicular; but is more than compenſated by the advantages above mentioned.

The human ſkeleton is generally divided into the HEAD, the TRUNK, the SUPERIOR, and the INFERIOR EXTREMITIES.

OF

(*b*) Cowper's Anat. of human bodies, explic. of tab. 87, 88.

Of the HEAD.

BY the *HEAD*, is meant all that ſpheroidal part which is placed above the firſt bone of the neck. It therefore comprehends the *cranium* and bones of the *face*.

The *cranium* (*c*), helmet, or brain-caſe, conſiſts of ſeveral pieces, which form a vaulted cavity, for lodging and defending the brain and *cerebellum*, with their membranes, veſſels, and nerves.

The cavity of the *cranium* is proportioned to its contents. Hence ſuch a variety of its ſize is obſerved in different ſubjects; and hence it is neither ſo broad nor ſo deep at its fore-part, in which the anterior lobes of the brain are lodged, as it is behind, where the large poſterior lobes of the brain, and the whole *cerebellum*, are contained.

The roundiſh figure of the ſkull, which makes it more capacious, and better able to defend its contents from external injuries, is chiefly owing to the equal preſſure of theſe contained parts as they grow and increaſe before it is entirely oſſified.—It is to be obſerved, however, that the ſides of the *cranium* are depreſſed below a ſpherical ſurface by the ſtrong temporal muſcles, whoſe action hinders here the uniform protruſion of the bones, which is more equally performed in other parts, where no ſuch large muſcles are. In children, whoſe muſcles have not acted much, and conſequently have not had great effects on the bones, this depreſſion is not ſo remarkable; and therefore their heads are much rounder than in adults. Theſe natural cauſes, differently diſpoſed in different people, produce a great variety in the ſhapes of ſkulls, which is ſtill increaſed by the different management of the heads of children when very young: So that one may know a *Turk*'s ſkull by its globular figure, a *German*'s by its breadth and flatneſs of the *occiput*, *Dutch*

(*c*) Κογχος, κυτος, κωδεια, σκαφιον, calva, calvaria, cerebri galea, theca et olla capitis, teſta capitis, ſcutella capitis.

Dutch and *Engliſh* by their oblong ſhapes, *&c.* (*d*). Two advantages are reaped from this flatneſs of the ſides of the *cranium*, *viz.* the enlargement of our ſphere of viſion, and more advantageous ſituation of our ears, for receiving a greater quantity of ſound, and for being leſs expoſed to injuries.

The external ſurface of the upper part of the *cranium* is very ſmooth, and equal, being only covered with the *perioſteum*, (common to all the bones; but in the ſkull, diſtinguiſhed by the name of *pericranium*), the thin *frontal* and *occipital* muſcles, their tendinous *aponeuroſis*, and with the common teguments of the body; while the external ſurface of its lower part has numerous riſings, depreſſions, and holes, which afford convenient origin and inſertion to the muſcles that are connected to it, and allow ſafe paſſage for the veſſels and nerves that run through and near it.

The internal ſurface of the upper part of the ſkull is commonly ſmooth, except where the veſſels of the *dura mater* have made furrows in it, while the bones were ſoft.—Surgeons ſhould be cautious when they trepan here, leſt, in ſawing or raiſing the bone where ſuch furrows are, they wound theſe veſſels.—In the upper part of the internal ſurface of ſeveral ſkulls, there are likewiſe pits of different magnitudes and figures, which ſeem to be formed by ſome parts of the brain being more luxuriant and prominent than others. Where theſe pits are, the ſkull is ſo much thinner than any where elſe, that it is often rendered diaphanous, the two tables being cloſely compacted without a *diploe;* the want of which is ſupplied by veſſels going from the *dura mater* into a great many ſmall holes obſervable in the pits. Theſe veſſels are larger, and much more conſpicuous than any others that are ſent from the *dura mater* to the ſkull; as evidently appears from the drops of blood they pour out, when the ſkull is raiſed from the *dura mater* in a recent ſubject; and therefore they may furniſh

(*d*) Veſal. lib. 1. c. 5.

urniſh a ſufficient quantity of liquors neceſſary to revent the brittleneſs of this thin part.—The knowedge of theſe pits ſhould teach ſurgeons to ſaw cauiouſly and ſlowly through the external table of the kull, when they are performing the operation of the *repan*; ſince, in a patient whoſe *cranium* has theſe its, the *dura mater* and brain may be injured, beore the inſtrument has pierced near the ordinary hickneſs of a table of the ſkull.—The internal baſe f the ſkull is extremely unequal, for lodging the ſeeral parts and *appendices* of the brain and *cerebellum*, nd allowing paſſage and defence to the veſſels and erves that go into, or come out from theſe parts.

The bones of the *cranium* are compoſed of two ables, and intermediate *cancelli*, commonly called their *diploe* (*e*). The external table is thickeſt; he inner, from its thinneſs and conſequent brittleeſs, has got the name of *vitrea*. Whence we may ee the reaſon of thoſe miſchievous conſequences which ſo often attend a collection of matter in the *liploe*, either from an external or internal cauſe, beore any ſign of ſuch a collection appears in the teguments that cover the part of the ſkull where it is odged (*f*).

The *diploe* has much the ſame texture and uſes in he ſkull, as the *cancelli* have in other bones.

The *diploe* of ſeveral old ſubjects is ſo obliterated, hat ſcarce any veſtige of it can be ſeen; neither is t obſervable in ſome of the hard craggy bones at the aſe of the ſkull. Hence an uſeful caution to ſurgeons who truſt to the bleeding, want of reſiſtance, nd change of ſound, as certain marks in the operaion of the trepan, for knowing when their inſtrunent has ſawed through the firſt table, and reached he *diploe* (*g*). In other people, the *diploe* becomes f a monſtrous thickneſs, while the tables of the kull are thinner than paper.

(*e*) Meditullium, commiſſura.

(*f*) Bonet. Sepulchret. anat. lib. 1. § 1. obſ. 96.—103.

(*g*) Bartholin. Anat. reform. lib. 4. cap. 4.

The *cranium* confifts of eight bones, fix of which are faid to be proper, and the other two are reckoned common to it and to the face.—The fix proper are, the *os frontis*, two *offa parietalia*, two *offa temporum*, and the *os occipitis*.—The common are the *os ethmoides* and *fphenoides*.

The *os frontis* forms the whole fore part of the vault; the two *offa parietalia* form the upper and middle part of it; the *offa temporum*, compofe the lower part of the fides; the *os occipitis* makes the whole hinder part, and fome of the bafe; the *os ethmoides* is placed in the fore part of the bafe, and the *os fphenoides* is in the middle of it.

Thefe bones are joined to each other by five *futures*; the names of which are, the *coronal*, *lambdoid*, *faggital*, and two *fquamous*.

The *coronal* (*h*) future is extended over the head, from within an inch or fo of the external *canthus* of one eye, to the like diftance from the other; which being near the place where the ancients wore their *vittæ*, *coronæ*, or garlands, this future has hence got its name.—Though the indentations of this future are confpicuous in its upper part, yet an inch or more of its end on each fide has none of them; for it is fquamous and fmooth there.

The *lambdoidal* (*i*) future begins fome way below, and farther back than the *vertex* or crown of the head, whence its two legs are ftretched obliquely downwards, and to each fide, in form of the *Greek* letter Δ, and are now generally faid to extend themfelves to the *bafe* of the fkull; but formerly anatomifts (*k*) reckoned the proper *lambdoid* future to terminate at the *fquamous* futures, and what is extended at an angle down from that on each fide, where the indentations are lefs confpicuous than in the upper part of the future, they called *additamentum futuræ lambdoidis* (*l*).

This

(*h*) Στεφαναῖα, arcualis, puppis.
(*i*) Laudæ, proræ, hypfyloides.
(*k*) Vefal. Anat. lib. I. cap. 6.
(*l*) Lambdoides harmonialis, lambdoides inferior, occipitis corona.

This *future* is fometimes very irregular, being made up of a great many fmall futures, which furround fo many little bones that are generally larger and more confpicuous on the external furface of the fkull, than internally. Thefe bones are generally called *triquetra*, or *Wormiana*; but fome other name ought to be given them, for they are not always of a triangular figure; and older anatomifts (*m*) than *Olaus Wormius* (*n*) have defcribed them.—The fpecific virtue which thefe bones were once thought to have in the cure of the epilepfy (*o*) is not now afcribed to them; and anatomifts generally agree, that their formation is owing to a greater number of points than ordinary of offification in the fkull, or to the ordinary bones of the *cranium* not extending their offification far enough or foon enough; in which cafe, the unoffified interftice between fuch bones begins a feparate offification in one or more points: from which the offification is extended to form as many diftinct bones as there were points that are indented into the large ordinary bones, and into each other.—Probably thofe children who have a large opening in this place at their birth, will have the largeft *offa triquetra*.—To confirm this account of the formation of thefe little bones, we may remark, that fuch bones are fometimes feen in other futures, as well as in the *lambdoid* (*p*), and they are fometimes in one table of the fkull, and not in the other (*q*.)

The *fagittal* future (*r*) is placed longitudinally in the middle of the upper part of the fkull, and commonly

E 2

(*m*) Euftach. Offium examen.—Bauhin. Theat. anat. lib. 3. cap. 5.—Paaw in Hippocrat. de vulner. cap. p. 56.

(*n*) Mufæum, lib. 3. cap. 26.

(*o*) Bauhin. et Paaw. ibid.—Bartholin. Anat. reform. lib. 4. cap. 5.—Hildan. Epift. 65.

(*p*) See Examples in Vefal. lib. 1. cap. 6. fig. 4.—Paaw in Hippocrat. de cap. vuln.—Bartholin. Hift. anat. cent. 1. hift. 51.—Ruyfch. Muf. anat.—Sue Trad. d'ofteolog. p. 47.

(*q*) Hunauld Mem. de l'acad. des. fciences, 1730.

(*r*) Ῥαβδοειδης, ὀβελιαια, ἐπιζευγνυσα, Inftar virgæ, nervalis, inftar teli, inftar veru, fecundum capitis longitudinem prorepens, conjungens, columnalis, recta, acualis.

monly terminates at the middle of the *coronal*, and of the *lambdoid* futures; between which it is faid to be placed, as an arrow is between the ftring and bow.—However, this future is frequently continued through the middle of the *os frontis*, down to the root of the nofe; which, fome (*s*) fay, oftener happens in women than men; but others (*t*) alledge, that it is to be met with more frequently in male fkulls than in female: Among the fkulls which I have feen thus divided, the female are the moft numerous.—Several (*u*) have delineated and defcribed the *fagittal* future, fometimes dividing the *occipital* bone as far down as the great hole through which the *medulla fpinalis* paffes. This I never faw.

In fome old fculls that are in my poffeffion, there is fcarce a veftige of any of the three *futures* which I have now defcribed. In other heads, one or two of the futures only difappear; but I never could difcover any reafon for thinking them difpofed in fuch different manners in fculls of different fhapes, as fome ancients alledge they are (*d*).

The *fquamous agglutinations*, or *falfe futures* (*e*), are one on each fide, a little above the ear, of a femicircular figure, formed by the overlopping (like one fcale upon another) of the upper part of the *temporal* bones on the lower part of the *parietal*, where, in both bones, there are a great many fmall rifings and furrows, which are indented into each other; though thefe inequalities do not appear till the bones are feparated. In fome fculls indeed the indentations here are as confpicuous externally as in other futures (*f*); and what is commonly called the pofterior part of this fquamous

(*s*) Riolan. Comment. de offib. cap. 8.

(*t*) Vefal. lib. 1. cap. 6. et in epitome.

(*u*) Vefal. lib. 1. cap. 5. fig 3, 4. et in text. cap. 6.——Paaw in Celf. de re medic. cap. 1.—Laurent. Hift. anat. lib. 2. cap. 16.

(*d*) Hippocrat. de vulner. capitis, fect. 1.—Galen de offib. et de ufu part. lib. 9. cap. 17.

(*e*) Λεπιδοειδη, προσκολληματα, κροταφιαι, temporales, corticales, mendofæ, harmoniales, commiffuræ in unguem.

(*f*) Columb. de re anat. lib. 1. cap. 4.—Dionis Anat. 3. demonft. des os.

ſquamous ſuture, always has the evident ſerrated form; and therefore is reckoned by ſome (g), a diſtinct ſuture, under the name of *additamentum poſterius ſuturæ ſquamoſæ*.—I have ſeen two ſquamous ſutures on the ſame temple, with a ſemicircular piece of bone between them (h).

We ought here to remark, that the true ſquamous ſort of ſuture is not confined to the conjunction of the temporal and parietal bones, but is made uſe of to join all the edges of the bones on which each temporal muſcle is placed (i): For the two parts of the ſphenoidal ſuture which are continued from the anterior end of the common ſquamous ſuture juſt now deſcribed, of which one runs perpendicularly downwards, and the other horizontally forwards, and alſo the lower part of the coronal ſuture already taken notice of, may all be juſtly ſaid to pertain to the ſquamous *ſuture*.—The manner how I imagine this ſort of ſuture is formed at theſe places, is, That by the action of the ſtrong temporal muſcles on one ſide, and by the preſſure of the brain on the other, the bones are made ſo thin, that they have not large enough ſurfaces oppoſed to each other to ſtop the extenſion of their fibres in length, and thus to cauſe the common ſerrated appearance of ſutures explained in p. 30. but the narrow edge of the one bone ſlides over the other. The *ſquamous* form is alſo more convenient here; becauſe ſuch thin edges of bones, when accurately applied one to another, have ſcarce any rough ſurface, to obſtruct or hurt the muſcle in its contraction; which is ſtill further provided for, by the manner of laying theſe edges on each other; for in viewing their outſide, we ſee the temporal bones covering the ſphenoidal and parietal, and this laſt ſupporting the ſphenoidal, while both mount on the frontal: from which diſpoſition it is evident, that while the temporal muſcle is contracting, which is the only time it preſſes

 ſtrongly

(g) Albin. de oſſib. ſect. 54.

(h) Sue Trad. d'oſteolog. p. 48.

(i) Veſal. Anat. lib. 1. cap. 6.——Winſlow Mem. de l'acad. des ſciences, 1720.

ſtrongly in its motion on the bones, its fibres ſlide eaſily over the external edges. Another advantage ſtill in this is, that all this bony part is made ſtronger by the bones thus ſupporting each other.

The bones of the ſcull are joined to thoſe of the face, by *ſchyndeleſis* and *ſutures*.—The *ſchyndeleſis* is in the partition of the noſe.—The ſutures ſaid to be common to the *cranium* and face are five, *viz.* the *ethmoidal*, *ſphenoidal*, *tranſverſe*, and two *zygomatic*.—Parts however of theſe ſutures are at the junction of only the bones of the ſcull.

The *ethmoidal* and *ſphenoidal* ſutures ſurround the bones of theſe names; and in ſome places help to make up other ſutures, particularly the *ſquamous* and *tranſverſe*; and in other parts there is but one ſuture common to theſe two bones.

The *tranſverſe* ſuture is extended quite croſs the face, from the external *canthus* of one orbit to the ſame place of the other, by ſinking from the *canthus* down the outſide of the orbit to its bottom; then mounting upon its inſide, it is continued by the root of the noſe down the internal part of the other orbit, and riſes up again on its outſide to the other *canthus*. It may be here remarked, that there are ſome interruptions of this ſuture in the courſe I have deſcribed; for the bones are not contiguous every where, but are ſeparated, to leave holes and apertures, to be mentioned hereafter.

The *zygomatic* ſutures are one on each ſide, being ſhort, and ſlanting from above obliquely downwards and backwards, to join a proceſs of the cheek-bone to one of the *temporal* bones, which advances towards the face; ſo that the two proceſſes thus united, form a ſort of bridge, or *jugum*, under which the *temporal* muſcle paſſes; on which account the proceſſes, and ſuture joining them, have been called *zygomatic*.

It muſt be obſerved, that the indentations of the *ſutures* do not appear on the inſide of the *cranium*, by much ſo ſtrong as on the outſide: but the bones ſeem almoſt joined in a ſtraight line; nay, in ſome ſculls,

fculls, the internal furface is found entire, while the futures are manifeft without; which may poffibly be owing to the lefs extent of the concave than of the convex furface of the *cranium*, whereby the fibres of the internal fide would be ftretched farther out at the edges of the bones, than the exterior ones, if they were not refifted. The refiftances are the fibres of the oppofite bone, the parts within the fcull, and the *diploe*; of which the laft being the weakeft, the moft advanced fibres or *ferræ* run into it, and leave the contiguous edges equal, and more ready to unite: whereas the *ferræ* of the external table have fpace enough for their admiffion between the fibres of the oppofite bone, and therefore remain of the indented form, and are lefs liable to the concretion, whereby the futures are obliterated (*a*).—By this mechanifm, there is no rifk of the fharp points of the bones growing inwards, fince the external *ferræ* of each of the conjoined bones reft upon the internal fmooth edged table of the other; and external forces applied to thefe parts are ftrongly refifted, becaufe the futures cannot yield, unlefs the ferrated edges of the one bone, and the plain internal plate of the other, are broken (*b*).

The advantages of the futures of the *cranium* are thefe: 1. That this *capfula* is more eafily formed and extended into a fpherical figure, than if it had been one continued bone. 2. That the bones which are at fome diftance from each other at birth, might then yield, and allow to the head a change of fhape, accommodated to the paffage it is engaged in. Whence, in hard labour of child-bed, the bones of the *cranium*, inftead of being only brought into contact, are fometimes made to mount one upon the other. 3. It is alledged, that, through the futures, there is a tranfpiration of fteams from the brain, which was the old doctrine; or fome communication of the veffels without, and of thofe within the fcull, larger here than in any other part of the *cranium*, according to fome moderns;

(*a*) Hunauld Memoires de l'acad. des fciences, 1730.
(*b*) Winflow Memoires de l'acad. des fciences, 1720.

moderns; and therefore *cucuphæ*, *fomentations*, *cataplasms*, *cephalic plasters*, *blisters*, are applied, and *issues* are eroded, or cut in the head, at those places where the sutures are longest in forming, and where the connection of the bones is afterwards loosest, for the cure of a *phrenitis*, *mania*, *inveterate headach*, *epilepsy*, *apoplexy*, and other diseases of the head. The favourers of the doctrine of transpiration, or communication of vessels at the sutures, endeavour to support it by observations of persons subject to headachs which caused death, from the sutures being too closely united (*a*). 4. That the *dura mater* may be more firmly suspended by its processes, which insinuate themselves into this conjunction of the bones; for doing this equally, and where the greatest necessity of adhesion is, the sutures are disposed at nearly equal distances, and the large *reservoirs* of blood, the *sinuses*, are under or near them. 5. That fractures might be prevented from reaching so far as they would in a continued bony substance. 6. That the connection at the sutures being capable of yielding, the bones might be allowed to separate; which has given great relief to patients from the violent symptoms which they had before this separation happened (*d*). And it seems reasonable to believe, that the opening of the sutures was of great benefit to several others who were rather judged to have been hurt by it (*b*): for we must think, that the consequences of such a force acting upon the brain, as was capable of thrusting the bones asunder, must have been fatal, unless it had been thus yielded to.

Having gone through the general structure of the *cranium*, I now proceed to examine each bone of which

(*a*) Columb. de re anat. lib. 1. cap. 5.—Verduc. nouvelle osteologie, chap. 14.—Dionis Anat. 3. demonstr. des os.

(*d*) Ephemerid. Germanic. dec. 1. ann. 4. et 5. observ. 33.

(*b*) Ephemerid. Germ. dec. 2. ann. 9. obs. 230. Ibid. cent. 10. obs. 31.---Vander Linden Medicin. physl. cap. 8. art. 4. § 16.---Hildan. Observ. cent. 1. obs. 1. cent. 2. obs. 7.---Bauhin. Theat. anat. lib. 3. cap. 6.---Pechlin. Observ. lib. 2. observ. 39.

of which that brain-cafe confifts, in the order in which I firft named them.

The *OS FRONTIS* (*c*) has its name from its being the only bone of that part of the face we call the *fore-head*, though it reaches a good deal farther. It has fome refemblance in fhape to the fhell of the *concha bevalvis*, commonly called the *cockle*; for the greateft part of it is convex externally, and concave internally, with a ferrated circular edge; while the fmaller part has proceffes and depreffions, which make it of an irregular figure.

The external furface of the *os frontis* is fmooth at its upper convex part; but feveral proceffes and cavities are obfervable below: for, at each angle of each orbit, the bone juts out, to form four proceffes, two internal, and as many external; which, from this fituation, may well enough be named *angular*. Between the internal and external angular proceffes on each fide, an arched ridge is extended, on which the eye-brows are placed.——Very little above the internal end of each of thefe *fuperciliary* ridges, a protuberance may be remarked, in moft fculls, where there are large cavities, called *finufes*, within the bone; of which hereafter.—Betwixt the internal angular proceffes, a fmall procefs rifes, which forms fome fhare of the nofe, and thence is named *nafal*.——Some obferve a protuberant part on the edge of the bone behind each external angular procefs, which they call *temporal* proceffes; but thefe are inconfiderable.—— From the under part of the fuperciliary ridges, the frontal bone runs a great way backwards: which parts may juftly enough be called *orbitar* proceffes. Thefe, contrary to the reft of this bone, are concave externally, for receiving the globes of the eyes, with their mufcles, fat, &c.

In each of the *orbitar* proceffes, behind the middle of the fuperciliary ridges, a confiderable finuofity is obferved, where the *glandula innominata Galeni* or *la-chrymalis*

(*c*) Μετωπον, Βρέγμα, coronale, inverecundum, puppis, fenfus communis, fincipitis.

chrymalis is lodged.—Behind each internal angular procefs, a fmall pit may be remarked, where the cartilaginous pully of the *mufculus obliquus major* of the eye is fixed.—Betwixt the two orbitar proceffes, there is a large difcontinuation of the bone, into which the cribriform part of the *os ethmoides* is incafed.—The frontal bone frequently has little caverns formed in it here where it is joined to the ethmoid bone.——Behind each external angular procefs, the furface of the frontal bone is confiderably depreffed where part of the *temporal* mufcle is placed.

The *foramina*, or holes, obfervable on the external furface of the frontal bone, are three in each fide.—One in each fuperciliary ridge, a little removed from its middle towards the nofe; through which a twig of the *ophthalmic* branch of the fifth pair of nerves paffes out of the orbit, with a fmall artery from the internal carotid, to be diftributed to the teguments and mufcles of the forehead.—Thefe veffels in fome fculls make furrows in the *os frontis*, efpecially in the bones of children, as has alfo been obferved of another confiderable veffel of this bone near its middle (*a*); and therefore we ought to beware of tranfverfe incifions on either fide of the *os frontis*, which might either open thefe veffels or hurt the nerves, while they are yet in part within the bone; for, when veffels are thus wounded, it is difficult to ftop the hæmorrhagy, becaufe the adhefion of a part of the artery to the bone hinders its contraction, and confequently ftyptics can have little effect; the fides of the furrow keep off compreffing fubftances from the artery; and we would wifh to fhun cauteries or efcharotics, becaufe they make the bone carious; and nerves, when thus hurt, fometimes produce violent fymptoms.—But, to return to the *fuperciliary foramina*, we muft remark, that often, inftead of a hole, a notch only is to be feen: Nay, in fome fculls, fcarce a veftige even of this is left; in others, both hole and notch are obfervable, when the nerve and artery run feparately. Frequently

(*a*) Ruyfch. Muf. anat. theca D. repofit. 4. No. 3.

Frequently a hole is found on one ſide, and a notch on the other; at other times we ſee two holes; or there is a common hole without, and two diſtinct entries internally. The reaſon of this variety of a hole, notch, depreſſion, or ſmoothneſs in the ſuperciliary ridge, is the different length and tenſion of the nerves and veſſels; the ſhorter they are, the more they are ſunk into the bone as it grows.—Near the middle of the inſide of each orbit, hard by, or in the *tranſverſe ſuture*, there is a ſmall hole for the paſſage of the naſal twig of the firſt branch of the fifth pair of nerves, and of a branch of the ophthalmic artery. This hole is ſometimes entirely formed in the *os frontis*; in other ſculls, the ſides of it are compoſed of this laſt bone, and of the *os planum*. It is commonly known by the name of *orbitarium internum*, though *anterius* ſhould be added, becauſe of the next, which is commonly omitted.—This, which may be called *orbitarium internum poſterius*, is ſuch another as the former; only ſmaller, and about an inch deeper in the orbit: through it a ſmall branch of the ocular artery paſſes to the noſe.—Beſides theſe ſix, there are a great number of ſmall holes obſervable on the outer ſurface of this bone, particularly in the two protuberances above the eye-brows. Moſt of theſe penetrate no further than the *ſinuſes*, or than the *diploe*, if the *ſinuſes* are wanting; though ſometimes I have ſeen this bone ſo perforated by a vaſt number of theſe ſmall holes, that, placed between the eye and a clear light, it appeared like a ſieve.—In the orbit of the generality of *ſkeletons*, we may obſerve one, two, or more holes, which allow a paſſage to a hog's briſtle through the ſcull. The place, ſize, and number of theſe, are however uncertain: They generally ſerve for the tranſmiſſion of ſmall arteries or nerves.

The internal ſurface of the *os frontis* is concave, except at the orbitar proceſſes, which are convex, to ſupport the anterior lobes of the brain. This ſurface is not ſo ſmooth as the external; for the larger branches

of

of the arteries of the *dura mater* make ſome furrows in its ſides and back parts. The ſinuoſities from the luxuriant riſings of the brain, mentioned when deſcribing the general ſtructure of the *cranium*, are often very obſervable on its upper part; and its lower and fore parts are marked with the contortions of the anterior lobes of the brain.—Through the middle of this internal ſurface, where always in children, and ſometimes in old people, the bone is divided, either a ridge ſtands out, to which the upper edge of the *falx* is faſtened, or a furrow runs, in which the upper ſide of the ſuperior longitudinal *ſinus* is lodged; on both theſe accounts chirurgical authors juſtly diſcharge the application of the trepan here.—The reaſon of this difference in ſculls, is alledged by ſome authors to be this, That in thin ſculls the ridge ſtrengthens the bones, and in thick ones there is no occaſion for it. To this way of accounting for this phœnomenon, it may juſtly be objected, that generally very thick ſculls have a large ſpine here, and frequently thin ones have only a furrow. Perhaps this variety may be owing to the different times of compleat oſſification of thoſe parts in different ſubjects; for if the two ſides of this bone meet before they arrive at their utmoſt extent of growth, they unite very firmly, and all their fibres endeavour to ſtretch themſelves out where the leaſt reſiſtance is, that is, between the hemiſpheres of the brain. To ſupport this reaſoning, we may remark, that thoſe adults, whoſe frontal bone is divided by the ſagittal ſuture, never have a ridge in this place.

Immediately at the root of this ridge or furrow, there is a ſmall hole, which ſometimes pierces through the firſt table, and, in other ſculls, opens into the ſuperior *ſinus* of the *ethmoid* bone within the noſe. In it a little proceſs of the *falx* is lodged, and a ſmall artery, and ſometimes a vein, runs (*a*); and the ſuperior longitudinal *ſinus* begins here.—This hole, however, is often not entirely proper to the *os frontis*; for, in

(*a*) Morgagn. Adverſar. 6. animad. 31.

in ſeveral ſculls, the lower part of it is formed in the upper part of the baſe of the *criſta galli*, which is a proceſs of the *ethmoid* bone (z).

The *os frontis* is compoſed of two tables, and an intermediate *diploe*, as the other bones of the *cranium* are, and in a middle degree of thickneſs between the *os occipitis* and the *parietal* bones; is pretty equally denſe all through, except at the orbitar proceſſes, where, by the action of the eye on one ſide, and preſſure of the lobes of the brain on the other, it is made extremely thin and diaphanous, and the *meditullium* is entirely obliterated. Since in this place there is ſo weak a defence for the brain, the reaſon appears, why fencers eſteem a puſh in the eye mortal (*a*).

The *diploe* is alſo exhauſted in that part above the eye-brows, where the two tables of the bone ſeparate, by the external being protruded outwards, to form two large cavities called *ſinus frontales*.—These are divided by a middle perpendicular bony partition. —Their capacities in the ſame ſubject are ſeldom equal; in ſome the right, in others the left is largeſt.—And in different bones their ſize is as inconſtant; nay, I have examined ſome, where they were entirely wanting; which oftener happens in ſuch as have a flat forehead, and whoſe ſagittal ſuture is continued down to the noſe, than in others (*b*).—In ſome ſculls, beſides the large perpendicular *ſeptum*, there are ſeveral bony pillars, or ſhort partitions, found in each *ſinus*; in others theſe are wanting.—For the moſt part, the *ſeptum* is entire; at other times it is diſcontinued, and the two *ſinuſes* communicate.—When the *ſinuſes* are ſeen in ſuch ſculls as have the frontal bone divided by the ſagittal ſuture, the partition dividing theſe cavities is evidently compoſed of two plates, which eaſily ſeparate.—Each *ſinus* commonly

(z) Ingraſſ. Comment. in Galen. de oſſib. cap. 1. comment. 8.
(*a*) Ruyſch. Obſerv. anat. chir. obſerv. 54.—Diemerbroek Anat. l. 3. cap. 10.—Bonet. Sepulch. anat. lib. 4. § 3. obſerv. 17.
(*b*) Fallop. Expoſit. de oſſibus, cap. 13.

monly opens by a roundiſh ſmall hole, at the inner and lower part of the internal angular proceſſes, into a *ſinus* formed in the noſe, at the upper and back part of the *os unguis;* near to which there are alſo ſome other ſmall *ſinuſes* of this bone (*c*), the greater part of which open ſeparately, nearer the *ſeptum narium*, and often they terminate in the ſame common canal with the large ones.

In a natural and ſound ſtate, theſe cavities are of conſiderable advantage: for the organ of ſmelling being thus enlarged, the *effluvia* of odorous bodies more difficultly eſcape it; and their impreſſions being more numerous, are therefore ſtronger, and affect the organ more. That odorous particles may be applied to the membrane of the *ſinuſes*, is evident from the pain felt in this part of the forehead, when the *effluvia* of volatile ſpirits, or of ſtrong aromatics, are drawn up into the noſe by a quick inſpiration.—Theſe and the other cavities which open into the noſe, increaſe the ſound of our voice, and render it more melodious, by ſerving as ſo many vaults to reſound the notes.—Hence people labouring under a *coryza*, or ſtoppage of the noſe, from any other cauſe, when they are by the vulgar, though falſely, ſaid to ſpeak through their noſe, have ſuch a diſagreeable harſh voice.—The liquor ſeparated in the membrane of theſe ſinuſes, drills down upon the membrane of the noſe to keep it moiſt.

From the deſcription of theſe *ſinuſes*, it is evident, how uſeleſs, nay, how pernicious it muſt be, to apply a trepan on this part of the ſcull; for this inſtrument, inſtead of piercing into the cavity of the *cranium*, would reach no further than the *ſinuſes;* or, if the inner table was perforated, any extravaſated blood that happened to be within the ſcull, would not be diſcharged outwardly, but would fall into the *ſinuſes*, there to ſtagnate, corrupt, and ſtimulate the ſenſible membranes; from which alſo there would be ſuch a conſtant flow of glary mucus, as would retard, if not

(*c*) Cowper in Drake's Anthropolog. book 3. chap. 10.

not hinder a cure, and would make the ſore degenerate into an incurable *fiſtula*. Beſides, as it would be almoſt impoſſible in this caſe to prevent the air, paſſing through the noſe, from having conſtant acceſs to the *dura mater*, or brain; ſuch a corruption would be brought on theſe parts as would be attended with great danger. Further, in reſpiration, the air ruſhing violently into theſe cavities of the *os frontis*, and paſſing through the external orifice, whenever it was not well covered and defended, would not only prevent the cloſing up of the external orifice, but might otherwiſe bring on bad conſequences (*d*).—The membrane lining theſe *ſinuſes* is ſo ſenſible, that inflammations of it muſt create violent torture (*e*); and worms, or other inſects crawling there, muſt give great uneaſineſs (*f*).

The upper circular part of the *os frontis*, is joined to the *oſſa parietalia*, from one temple to the other, by the coronal ſuture. From the termination of the coronal ſuture, to the external angular proceſſes, this bone is connected to the *ſphenoid* by the *ſphenoidal* ſuture. At the external *canthi* of the eyes, its angular proceſſes are joined by the tranſverſe ſuture to the *oſſa malarum*, to which it adheres one third down the outſide of the orbits; whence to the bottom of theſe cavities, and a little up on their internal ſides, theſe orbitar proceſſes are connected to the *ſphenoidal* bone by that ſame ſuture.—In ſome few ſculls, however, a diſcontinuation of theſe two bones appears at the upper part of the long ſlit, near the bottom of the orbit.—On the inſide of each orbit, the orbitar proceſs is indented between the *cribriform* part of the *ethmoid* bone, and the *os planum* and *unguis*.—The tranſverſe ſuture afterwards joins the frontal bone to the ſuperior naſal proceſſes of the *oſſa maxillaria ſuperiora*,

(*d*) Paaw de oſſibus, pars 1. cap. 7.—Palfyne Anat. chir. traité 4. chap. 15.—Nouvelle oſteologie, partie 2. chap. 3.

(*e*) Fernel. Patholog. lib. 5. cap. 7.—Saltzman. Decur. obſ. 10.

(*f*) Fernel. Patholog. lib. 5. cap. 7.—Bartholin. Epiſtol. medic. cent. 2. epiſt. 74.—Hiſt. de l'acad. des ſciences, 1708 & 1733.

riora, and to the nafal bones. And, *laftly*, its nafal procefs is connected to the nafal *lamella* of the *ethmoid* bone.

The *frontal* bone ferves to defend and fupport the anterior lobes of the brain. It forms a confiderable part of the cavities that contain the globes of the eyes, helps to make up the *feptum narium*, organ of fmelling, &c. From the defcription of the feveral parts, the other ufes of this bone are evident.

In a ripe child, the frontal bone is divided through the middle; the fuperciliary holes are not formed; often a fmall round piece of each orbitar procefs, behind the fuperciliary ridge, is not offified, and there is no *finus* to be feen within its fubftance.

Each of the two *OSSA PARIETALIA* (g), or bones ferving as walls to the *encephalon*, is an irregular fquare; its upper and fore fides being longer than the one behind or below. The inferior fide is a concave arch; the middle part receiving the upper round part of the temporal bone.—The angle formed by this upper fide, and the fore one, is fo extended, as to have the appearance of a procefs.

The external furface of each *os parietale* is convex. Upon it, fomewhat below the middle height of the bone, there is a tranfverfe arched ridge, of a whiter colour generally than any other part of the bone; from which, in bones that have ftrong prints of mufcles, we fee a great many converging furrows, like fo many *radii* drawn from a circumference towards a centre. From this ridge of each bone the temporal mufcle rifes; and, by the preffure of its fibres, occafions the furrows juft now mentioned.—Below thefe, we obferve near the femicircular edges, a great many rifings and depreffions, which are joined to like inequalities on the infide of the temporal bone, to form the fquamous future. The temporal bone may therefore ferve here as a buttrefs, to prevent

(g) Κορυφης, paria, fyncipitis, verticis, arcualia, nervalia, cogitationis, rationis, bregmatis, madefactionis.

vent the lower ſide of the parietal from ſtarting outwards when its upper part is preſſed or ſtruck (*h*).

Near the upper ſides of theſe bones, towards the hind part, is a ſmall hole in each, through which a vein paſſes from the teguments of the head to the longitudinal *ſinus*. Sometimes I have ſeen a branch of the temporal artery paſs through this hole, to be diſtributed to the upper part of the *falx*, and to the *dura mater* at its ſides, where it had frequent anaſtomoſes with the branches of the arteries derived from the external carotids, which commonly have the name of the arteries of the *dura mater*, and with the branches of the internal carotids which ſerve the *falx*. In ſeveral ſculls, one of the *oſſa parietalia* has not this hole: in others, there are two in one bone; and in ſome not one in either. Moſt frequently this hole is through both tables; at other times the external table is only perforated.—The knowledge of the courſe of theſe veſſels may be of uſe to ſurgeons, when they make any inciſion near this part of the head, leſt, if the veſſels are raſhly cut near the hole, they ſhrink within the ſubſtance of the bone, and ſo cauſe an obſtinate hæmorrhagy, which neither ligatures nor medicines can ſtop.

On the inner concave ſurface of the parietal bones, we ſee a great many deep furrows, diſpoſed ſomewhat like the branches of trees: The furrows are largeſt and deepeſt at the lower edge of each *os parietale*, eſpecially near its anterior angle, where ſometimes a full canal is formed. They afterwards divide into ſmall furrows, in their progreſs upwards.—In ſome ſculls a large furrow begins at the hole near the upper edge, and divides into branches, which join with thoſe which come upwards, ſhewing the communications of the upper and lower veſſels of the *dura mater*.—In theſe furrows we frequently ſee paſſages into the *diploe;* and ſometimes I have obſerved canals going off, which allowed a ſmall probe to paſs ſome

(*h*) Hunauld Mem. de l'acad. des ſciences, 1730.

inches into the bony ſubſtance? Some (*i*) tell us, that they have obſerved theſe canals piercing the bone towards the *occiput*.—On the inſide of the upper edge of the *oſſa parietalia*, there is a large ſinuoſity, frequently larger in the bone of one ſide than of the other, where the upper part of the *falx* is faſtened, and the ſuperior longitudinal *ſinus* is lodged.—Generally part of the latter *ſinuſes* makes a depreſſion near the angle, formed by the lower and poſterior ſides of theſe bones; and the pits made by the prominent parts of the brain are to be ſeen in no part of the ſcull more frequent, or more conſiderable, than in the internal ſurface of the parietal bones.

The *oſſa parietalia* are amongſt the thinneſt bones of the *cranium;* but enjoy the general ſtructure of two tables and *diploe* the completeſt, and are the moſt equal and ſmooth.

Theſe bones are joined at their fore-ſide to the *os frontis* by the coronal ſuture; at their long inferior angles, to the *ſphenoid bone*, by part of the ſuture of this name; at their lower edge, to the *oſſa temporum*, by the ſquamous ſuture, and its poſterior *additamentum;* behind, to the *os occipitis*, or *oſſa triquetra*, by the lambdoid ſuture; and above, to one another, by the ſagittal ſuture.

They have no particular uſes beſides thoſe mentioned in the deſcription of their ſeveral parts, except what are included in the account of the general ſtructure of the *cranium*.

In a child born at the full time, none of the ſides of this bone are completed; and there never is a hole in the oſſified part of it near to the ſagittal ſuture.

The large unoſſified ligamentous part of the *cranium* obſervable between the parietal bones, and the middle of the divided *os frontis* of new-born children, called by the vulgar the *open of the head*, was imagined by the ancients to ſerve for the evacuation of the ſuperfluous moiſture of the brain; and therefore they named

(*i*) Cowper's Anatom. explic. of 90 tab. fig. 2.

named it *bregma* (*l*), or the fountain; ſometimes adding the epithet *pulſatilis*, or beating, on account of the pulſation of the brain felt through this flexible ligamento-cartilaginous ſubſtance. Hence very frequently the parietal bones are called *oſſa bregmatis*.

The upper middle part of the head of a child, in a natural birth, being what preſents itſelf firſt at the *os uteri* (*m*), an accoucheur may reach the *bregma* with his finger, when the *os uteri* is a little opened. If the *bregma* is ſtretched, and the pulſation of the brain is felt through it, the child is certainly alive: But if it is ſhrivelled and flaccid, without any obſervable pulſation in it, there is ſome reaſon to ſuſpect the child to be very weak, or dead. Thoſe who practiſe midwifery ſhould therefore examine the ſtate of the *bregma* accurately.

All the *bregma* is generally oſſified before ſeven years of age. Several authors (*n*) ſay, they have obſerved it unoſſified in adults; and phyſicians, who order the application of medicines at the meeting of the coronal and ſagittal ſutures, ſeem yet to think, that a derivation of noxious humours from the *encephalon* is more eaſily procured at this part than any other of the ſcull; and that medicines have a greater effect here than elſewhere, in the internal diſorders of the head.

OSSA TEMPORUM (*o*), ſo named, ſay authors, from the hair's firſt becoming gray on the temples, and thus diſcovering peoples ages, are each of them equal and ſmooth above, with a very thin ſemicircular edge; which, from the manner of its connection with the neighbouring bones, is diſtinguiſhed by the name of *os ſquamoſum*.—Behind this the upper part of

(*l*) Palpitans vertex, foliolum, folium, triangularis lacuna.

(*m*) Burton's Midwifery, § 51.—Smellie's Midwifery, book 1. chap. 1. § 5.

(*n*) Bartholin. Anat. reform. lib. 4. cap. 6—Diemerbroek Anat. lib. 9. cap. 6.—Kerckring. Oſteogen. cap. 2.

(*o*) Κορταφων, κορσων, κορρων λεπιδοειδη, πολυειδη, λιθοειδη, temporalia, lapidoſa, mendoſa, dura, arcualia, tympanum, armalia, ſaxea, parietalia.

of the temporal bone is thicker, and more unequal, and is ſometimes deſcribed as a diſtinct part, under the name of *pars mammillaris* (*p*).—Towards the baſe of the ſcull, the temporal bone appears very irregular and unequal; and this part, inſtead of being broad, and placed perpendicularly, as the others are, is contracted into an oblong very hard ſubſtance, extended horizontally forwards and inwards, which in its progreſs becomes ſmaller, and is commonly called *os petroſum*.

Three external proceſſes of each temporal bone are generally deſcribed.—The firſt placed at the lower and hind part of the bone, from its reſemblance to a nipple, is called *maſtoides*, or *mammillaris*. It is not ſolid, but within is compoſed of *cancelli*, or ſmall cells, which have a communication with the large cavity of the ear, the drum; and therefore ſounds, being multiplied in this vaulted labyrinth, are increaſed, before they are applied to the immediate organ of hearing. Into the maſtoid proceſs, the *ſtenomaſtoideus* muſcle is inſerted; and to its back part, where the ſurface is rough, the *trachelomaſtoideus*, and part of the *ſplenius* are fixed.—About an inch farther forward, the ſecond proceſs begins to riſe out from the bone; and having its origin continued obliquely downwards and forwards for ſome way, it becomes ſmaller; and is ſtretched forwards to join with the *os malæ*; they together forming the bony *jugum*, under which the temporal muſcle paſſes. Hence this proceſs has been named *zygomatic* (*a*). Its upper edge has the ſtrong aponeuroſis of the *temporal* muſcle fixed into it; and its lower part gives riſe to a ſhare of the *maſſeter*.—The fore part of the baſe of this proceſs is an oblong tubercle, which in a recent ſubject is covered with a ſmooth poliſhed cartilage, continued from that which lines the cavity immediately behind this tubercle.—From the under craggy part of the *os temporum*, the third

(*p*) Albin. de oſſib. ſect. 26.

(*a*) Καγχρος, paris, anſæ oſſium temporum, oſſa arcualia, paria, jugalia, conjugalia.

hird procefs ftands out obliquely forwards. The hape of it is generally faid to refemble the ancient *ftylos fcriptorius*: and therefore it is called the *ftyloid* procefs (*b*). Some authors (*c*) however contend, that t ought to be named *fteloid*, from its being more like o a pillar. Several mufcles have their origin from his procefs, and borrow one half of their name from t; as *ftylo-gloffus*, *ftylo-hyoideus*, *ftylo-pharyngeus*; to it ligament of the *os hyoides* is fometimes fixed; and anoher is extended from it to the infide of the angle of he lower jaw. This procefs is often, even in adults, not entirely offified, but is ligamentous at its root, and fometimes is compofed of two or three diftinct pieces.——Round the root of it, efpecially at the fore-part, there is a remarkable rifing of the *os petrofum*, which fome have efteemed a procefs; and, from he appearance it makes with the *ftyliform*, have named it *vaginalis*.—Others again have, under the name of *auditory* procefs, reckoned among the external proceffes that femicircular ridge, which, running between the root of the *maftoid* and *zygomatic* proceffes, forms the under part of the external *meatus auditorius*.

The finuofities or depreffions on the external furface of each *os temporum*, are thefe:—A long *foffa* at he inner and back part of the root of the mammary procefs, where the pofterior head of the *digaftric* mufcle has its origin.—Immediately before the root of the *zygomatic* procefs, a confiderable hollow is left, for lodging the *crotaphite* mufcle.—Between the *zygomatic*, *auditory*, and *vaginal* proceffes, a large cavity is formed; through the middle of which, from top to bottom, a fiffure is obfervable, into which part of the ligament that fecures the articulation of the lower jaw with this bone is fixed. The fore-part of the cavity being lined with the fame cartilage which covers he tubercle before it, receives the *condyle* of the jaw; and

(*b*) Γραφιοειδη, βελονοειδη, πληκτρον, os calaminum, fagittale, clavale, acuale, calcar capitis.

(*c*) Galen, de ufu part. lib. 2. cap 4.——Fallop. obferv. anatom.

and in the back part a ſmall ſhare of the parotid gland and a cellular fatty ſubſtance, are lodged.—At the inſide of the root of the *ſtyloid apophyſe*, there is a thimble-like cavity, where the beginning of the internal jugular vein, or end of the lateral *ſinus* is lodged.—And as the ſinuſes of the two ſides are frequently of unequal ſize; ſo one of theſe cavities is as often larger than the other (*d*).—Round the external *meatus auditorius*, ſeveral ſinuoſities are formed for receiving the cartilages and ligaments of the ear, and for their firm adheſion.

The *holes* that commonly appear on the outſide of each of theſe bones, and are proper to each of them, are five.—The *firſt*, ſituated between the *zygomatic* and *maſtoid* proceſſes, is the orifice of a large funnel-like canal, which leads to the organ of hearing; therefore is called *meatus auditorius externus* (*e*).—The *ſecond* gives paſſage to the *portio dura* of the ſeventh pair of nerves, and from its ſituation between the *maſtoid* and *ſtyloid* proceſſes, is called *foramen ſtylo-maſtoideum* (*g*).—Some way before, and to the inſide of the *ſtyloid* proceſs, is the *third* hole; the canal from which runs firſt upwards, then forwards, and receives into it the internal *carotid* artery, and the beginning of the intercoſtal nerve; where this canal is about to make the turn forwards, one, or ſometimes two very ſmall holes go off towards the cavity of the ear, called *tympanum;* through theſe *Valſalva* (*h*) affirms the proper artery or arteries of that cavity are ſent.—On the anterior edge of this bone, near the former, a *fourth* hole is obſervable, being the orifice of a canal which runs outwards and backwards, in a horizontal direction, till it terminates in the *tympanum*. This, in the recent ſubject, is continued forward and inward, from the parts which I mentioned juſt now as its orifice in the ſkeleton, to the ſide of the

(*d*) Hunauld Mem. de l'acad. des ſciences, 1730.

(*e*) Πορος της ακοης, οπη των ωτων, feneſtra aurium.

(*g*) Aquaeductus Fallopii.

(*h*) De aure humana, cap 2. § 22. et tab. 7. fig. 1.

the noftrils; being partly cartilaginous, and partly ligamentous. The whole canal is named, *Iter a palato ad aurem*, or *Euftachian tube.*—On the external fide of the bony part of this canal, and a-top of the chink in the cavity that receives the *condyle* of the lower jaw, is the courfe of the little nerve faid commonly to be reflected from the lingual branch of the fifth pair, till it enters the *tympanum*, to run acrofs this cavity, and to have the name of *chorda tympani.*—The *fifth* hole is very uncertain, appearing fometimes behind the *maftoid* procefs; fometimes it is common to the temporal and occipital bones; and in feveral fculls there is no fuch hole. The ufe of it, when found, is for the tranfmiffion of a vein from the external teguments to the lateral *finus*: But, in fome fubjects, a branch of the occipital artery paffes through this hole, to ferve the back part of the *dura mater*; in others, I have feen two or three fuch holes: But they are oftener wanting than found. And we may, once for all, in general remark, That the largenefs, number, fituation, and exiftence of all fuch holes, that for the moft part allow only a paffage for veins from without to the internal receptacles, are very uncertain.

The internal furface of the *offa temporum* is unequal; the upper circular edge of the fquamous part having numerous fmall ridges and furrows for its conjunction with the parietal bones; and the reft of it is irregularly marked with the convolutions of the middle part of the brain, and with furrows made by the branches of the ateries of the *dura mater*.

From the under part of this internal furface, a larger tranfverfe hard craggy protuberance runs horizontally inwards and forwards, with a fharp edge above, and two flat fides, one facing obliquely forwards and outwards, and the other as much backwards and inwards. To the ridge between thefe two fides, the large lateral procefs of the *dura mater* is fixed.

Sometimes a fmall bone, akin to the *fefamoid*, is found

found between the ſmall end of this *petrous* proceſs and the *ſphenoid* bone (*a*).

Towards the back part of the inſide of the *os temporum*, a large deep *foſſa* is conſpicuous, where the *lateral ſinus* lies; and frequently on the top of the *petrous* ridge, a furrow may be obſerved, where a ſmall ſinus is ſituated.

The internal proper *foramina* of each of theſe bones are, *firſt*, the internal *meatus auditorius* in the poſterior plain ſide of the petrous proceſs. This hole ſoon divides into two; one of which is the beginning of the *aquæduct* of *Fallopius*; the other ends in ſeveral very ſmall canals (*b*) that allow a paſſage to the branches of the *portio mollis* of the ſeventh pair of nerves, into the *veſtibule* and *cochlea*. Through it alſo an artery is ſent, to be diſtributed to the organ of hearing.—The *ſecond* hole, which is on the anterior plain ſide of the craggy proceſs, gives paſſage to a reflected branch of the ſecond branch of the fifth pair of nerves, which joins the *portio dura* of the auditory nerve, while it is in the *aquæduct* (*c*), ſmall branches of blood-veſſels accompanying the nerves or paſſing through ſmaller holes near this one.—The paſſage of the cutaneous vein into the lateral *ſinus*, or of a branch of the occipital artery, is ſeen about the middle of the large *foſſa* for that *ſinus*; and the orifice of the canal of the *carotid* artery is evident at the under part of the point of the *petrous* proceſs.

Beſides theſe proper holes of the temporal bones which appear on their external and internal ſurfaces, there are two others in each ſide that are common to this bone and to the *occipital* and *ſphenoidal* bones; which ſhall be mentioned afterwards in the deſcription of theſe bones.

The upper round part of the ſquamous bones is thin, but equal; while the low petrous part is thick and

(*a*) Riolan. Comment. de oſſib. cap. 32.—Winſlow Expoſition anatomique du corps humain, traité des os ſecs, § 266.

(*b*) Valſalv. De aure humana, cap. 3. § 11.

(*c*) Valſalv. de aure, cap. 3. § 10.

and ſtrong, but irregular and unequal, having the diſtinction of tables and *diploe* confounded, with ſeveral cavities, proceſſes, and bones within its ſubſtance, which are parts of the organ of hearing. That a clear idea may be had of this beautiful, but intricate organ, anatomiſts generally chooſe to demonſtrate all its parts together. I think the method good; and therefore, ſince it would be improper to inſert a complete treatiſe on the ear here, ſhall omit the deſcription of the parts contained within the *os petroſum* of the ſkeleton.

The temporal bones are joined above to the parietal bones by the ſquamous ſutures, and their poſterior *additamenta*: Before, to the *ſphenoid* bone by the ſuture of that name; to the cheek-bones by the *zygomatic* ſutures: Behind, to the *occipital* bone, by the *lambdoid* ſuture and its *additamenta;* and they are articulated with the *lower jaw*, in the manner which ſhall be deſcribed when this bone is examined.

The purpoſes which theſe two bones ſerve, are eaſily collected, from the general uſe of the *cranium*, and from what has been ſaid in the deſcription of their ſeveral parts.

In an infant, a ſmall fiſſure is to be obſerved between the thin upper part, and the lower craggy part of each of theſe bones; which points out the recent union of theſe parts.—Neither *maſtoid* nor *ſtyloid* proceſſes are yet to be ſeen.—Inſtead of a bony funnel-like external *meatus auditorius*, there is only a smooth bony ring, within which the membrane of the drum is faſtened.—At the entry of the *Euſtachian tube*, the ſide of the *tympanum* is not completed.—A little more outward than the internal auditory canal, there is a deep pit, over the upper part of whoſe orifice the interior ſemicircular canal of the ear is stretched; and ſome way below this, the poſterior ſemicircular canal alſo appears manifeſtly.

OS OCCIPITIS (*d*), ſo called from its ſitua-

tion,

(*d*) Ιvov, baſilare, proræ, memoriæ, pixidis, fibroſum, nervoſum, lambde.

tion, is convex on the outfide, and concave internally. Its figure is an irregular fquare, or rather *rhomboid;* of which the angle above is generally a little rounded; the two lateral angles are more finifhed, but obtufe; and the lower one is ftretched forward in form of a wedge, and thence is called by fome the *cuneiform* procefs.—If one would, however, be very nice in obferving the feveral turns which the edges of the *os occipitis* make, five or feven fides, and as many angles of this bone might be defcribed.

The external furface is convex, except at the cuneiform apophyfe, where it is flatted. At the bafe of this triangular procefs, on each fide of the great hole, but more advanced forwards than the middle of it, the large oblong protuberances, named the *condyles*, appear, to ferve for the articulation of this bone with the firft *vertebra* of the neck. The fmooth furface of each of thefe *condyloid* proceffes is longeft from behind forwards, where, by their oblique fituation, they come much nearer to each other than they are at their back part. Their inner fides are lower than the external, by which they are prevented from fliding to either fide out of the cavities of the firft *vertebra* (*e*). In fome fubjects each of thefe plain fmooth furfaces feems to be divided by a fmall rifing in its middle; and the lower edge of each condyle, next the great *foramen*, is difcontinued about the middle, by an intervening notch: Whence fome (*f*) alledge, that each of thefe *apophyfes* is made up of two protuberances.—Round their root a fmall depreffion and fpongy roughnefs is obfervable, where the ligaments for furrounding and fecuring their articulations adhere.—Though the motion of the head is performed on the condyles, yet the centre of gravity of that globe does not fall between them, but is a good way further forward; from which mechanifm it is evident, that the mufcles which pull the head back, muft be in a conftant ftate of contraction; which

(*e*) Galen. de ufu part. lib. 12. cap. 7.

(*f*) Diemerbroek Anat. lib. 9. cap. 6.

which is ſtronger than the natural contraction of the proper flexors, elſe the head would always fall forwards, as it does when a man is aſleep, or labours under a palſy, as well as in infants, where the weight of the head far exceeds the proportional ſtrength of theſe muſcles. This ſeeming diſadvantageous ſituation of the condyles, is however of good uſe to us, by allowing ſufficient ſpace for the cavities of the mouth and *fauces*, and for lodging a ſufficient number of muſcles, which commonly ſerve for other uſes; but may at pleaſure be directed to act on the head, and then have an advantageous lever to act with, ſo as to be able to ſuſtain a conſiderable weight appended, or other force applied, to pull the head back.

Somewhat more externally than the *condyles*, there is a ſmall riſing and ſemilunated hollow in each ſide, which make part of the holes, common to the *occipital* and *petrous* bones.—Immediately behind this, on each ſide, a ſcabrous ridge is extended from the middle of the condyle, towards the root of the *maſtoid* proceſs. Into this ridge the *muſculus lateralis*, commonly aſcribed to *Fallopius*, is inſerted.—About the middle of the external convex ſurface, a large arch runs croſs the bone; from the upper lateral parts of which the *occipital* muſcles have their riſe; to its middle the *trapezii* are attached: And half way between this and the great hole, a leſſer arch is extended.—In the hollows between the middle of theſe arches the *complexi* are inſerted; and in the depreſſions more external and further forward than theſe, the *ſplenii* are inſerted.—Between the middle of the leſſer arch and the great hole, the little hollow marks of the *recti minores* appear; and on each ſide of theſe the fleſhy inſertions of the *obliqui ſuperiores* and *recti majores* make depreſſions.—Through the middle of the two arches a ſmall ſharp *ſpine* is placed, which ſerves as ſome ſort of partition between the muſcles of different ſides, or rather is owing to the action of the muſcles depreſſing the bone on each ſide of it, while this part is free from their compreſſion.—Theſe

prints of the muscles on this bone are very strong and plain in some subjects, but are not so distinct in others. —All round the great *foramen*, the edges are unequal, for the firmer adhesion of the strong circular ligament, which goes thence to the first *vertebra*.—One end of each *lateral* or *moderator* ligament of the head, is fixed to a rough surface at the fore part of each condyle, and the *perpendicular* one is connected to a rough part of the edge of the great hole between the two condyles.—Immediately before the condyles, two little depressions are made in the external surface of the cuneiform process, for the insertion of the *recti anteriores minores* muscles which are unjustly ascribed to *Cowper*: And still further forward, near the *sphenoid* bone, are two other such depressions, for the reception of the *recti anteriores majores*.—When we consider the size of the prints of muscles on the occipital bone, before and behind its condyles, and, at the same time, compare their distances from these centres of motion of the head, we must see how much stronger the muscles are which pull the head backwards, than those are which bend it forward; and how much greater force the former acquire by the long lever they act with, than the latter which are inserted so near the condyles. This great force in the extensor muscles is altogether necessary, that they might not only keep the head from falling forward in an erect posture, but that they might support it when we bow forward in the most necessary offices of social life, when the weight of the head comes to act at right angles on the *vertebræ* of the neck, and obtains a long lever to act with.

On the inner surface of the *os occipitis* we see two ridges; one standing perpendicular, the other running horizontally across the first. The upper part of the perpendicular limb of the cross, to which the *falx* is fixed, is hollowed in the middle, or often on one side, for the reception of the *superior longitudinal sinus*, and the lower part of it has the small or third process of the *dura mater* fastened to it, and is some-

times.

times hollowed by the *occipital ſinus*. Each ſide of the horizontal limb is made hollow by the lateral ſinuſes incloſed in the tranſverſe proceſs of the *dura mater*; the *foſſa* in the right ſide being generally a continuation of the one made by the longitudinal ſinus in the perpendicular limb, and therefore is larger than the left one (*g*).—Round the middle of the croſs there are four large depreſſions ſeparated by its limbs; the two upper ones being formed by the back part of the brain, and the two lower ones by the *cerebellum*.—Farther forward than the laſt mentioned depreſſions, is the lower part of the *foſſa* for the lateral *ſinus* on each ſide.—The inner ſurface of the cuneiform apophyſe is made concave for the reception of the *medulla oblongata*, and of the *baſilar* artery.—A furrow is made on each ſide, near the edges of this proceſs, by a *ſinus* of the *dura mater*, which empties itſelf into the lateral *ſinus* (*h*).

The holes of this bone are commonly five proper, and two common to it and to the *temporal* bones.—The firſt of the proper holes, called *foramen magnum* (*i*), from its ſize, is immediately behind the wedge-like proceſs, and allows a paſſage to the *medulla oblongata*, *nervi acceſſorii*, to the vertebral arteries, and ſometimes to the vertebral veins.—At each ſide of this great hole, near its fore part, and immediately above the condyles, we always find a hole, ſometimes two, which ſoon unite again into one that opens externally; through theſe the ninth pair of nerves go out of the ſkull.—The fourth and fifth holes pierce from behind the *condyle* of each ſide into the *foſſæ* of the lateral *ſinuſes*; they ſerve for the paſſage of the cervical veins to theſe *ſinuſes*. Often one of theſe holes is wanting, ſometimes both, when the veins paſs through the great *foramen*.—Beſides theſe five, we frequently meet with other holes near the edges of this bone, for the tranſmiſſion of veins; but

(*g*) Morgagn. Adverſ. anat. 6. animad. 1.
(*h*) Albin. de oſſib. § 65.
(*i*) Rachitidis medullæ ſpinalis.

but their number and diameter are very uncertain. The two common *foramina* are the large irregular holes, one in each ſide, between the ſides of the *cuneiform* proceſs, and the edges of the *petrous* bones. In a recent ſubject, a ſtrong membrane runs croſs from one ſide to the other of each of theſe holes; in ſome heads I have ſeen this membrane oſſified, or a bony partition dividing each hole; and in the greater number of adult ſkulls, there is a ſmall ſharp-pointed proceſs ſtands out from the *os petroſum*, and a more obtuſe riſing in the occipital bone, between which the partition is ſtretched. Behind this partition, where the largeſt ſpace is left, the *lateral ſinus* has its paſſage; and before it the eighth pair of nerves and *acceſſorius* make their exit out of the ſkull; and ſome authors ſay, an artery paſſes through this hole, to be beſtowed on the *dura mater*.

The *occipital* bone is among the thickeſt of the *cranium*, though unequally ſo; for it is ſtronger above, where it has no other defence than the common teguments, than it is below, where, being preſſed by the lobes of the brain and *cerebellum* on one ſide, and by the action of the muſcles on the other, it is ſo very thin, as to be diaphanous in many ſkulls: But then theſe muſcles ward off injuries, and the ridges and ſpines, which are frequent here, make it ſufficiently ſtrong to reſiſt ordinary forces. The tables and *diploe* are tolerably diſtinct in this bone, except where it is ſo thin as to become diaphanous.

The occipital bone is joined above to the *oſſa parietalia* and *triquetra* when preſent, by the *lambdoid* ſuture;—laterally to the temporal bones, by the *additamenta* of the *lambdoid* ſuture;—below to the *ſphenoid* bone, by the end of its cuneiform proceſs, in the ſame way that epiphyſes and their bones are joined: For in children, a ligamentous cartilage is interpoſed between the occipital and ſphenoid bones, which gradually turns thinner, as each of the bones advances, till their fibres at laſt run into each other; and, about ſixteen or eighteen years of age, the union

of

of theſe two bones becomes ſo intimate, that a ſeparation cannot be made without violence.—The *os occipitis* is joined by a double articulation to the firſt *vertebra* of the neck, each condyle being received into a ſuperior oblique proceſs of that *vertebra*. What motion is allowed here, we ſhall conſider afterwards, where the *vertebræ* are deſcribed.

The uſes of this bone appear from the preceding deſcription, and therefore need not be repeated.

An infant born at the full time, has this bone divided, by unoſſified cartilages, into four parts.—The firſt of theſe is larger than the other three, is of a triangular ſhape, and conſtitutes all the part of the bone above the great *foramen*. Generally fiſſures appear in the upper part and ſides of this triangular bone, when all the cartilage is ſeparated by maceration; and ſometimes little diſtinct bones are ſeen towards the edges of it.—The ſecond and third pieces of this bone are exactly alike, and ſituated on each ſide of the great *foramen*; from which very near the whole condyles are produced; and they are extended forwards almoſt to the fore part of the hole for the ninth pair of nerves.—The fourth piece is the cuneiform proceſs, which forms a ſmall ſhare of the great hole, and of theſe for the ninth pair of nerves, and of the condyles: Betwixt it and the *ſphenoid* bone, a cartilage is interpoſed.

Of the eight bones which belong to the *cranium*, there are only two which are not yet deſcribed, *viz.* the *ethmoid* and *ſphenoid*. Theſe we already mentioned, in complaiſance to the generality of writers on this ſubject, as bones common to the *cranium* and face, becauſe they enter into the compoſition of both: But the ſame reaſon might equally be uſed for calling the frontal bone a common one too. I ſhall, however, paſs any idle diſpute about the propriety of ranging them, and proceed to examine the ſtructure of the bones themſelves.

OS ETHMOIDES (*k*), or the ſieve-like bone, has

(*k*) Cribriforme, σπογγοειδης, ſpongiforme, criſtatum.

has got its name from the great number of ſmall holes with which that part of it firſt taken notice of is pierced. When this bone is entire, the figure of it is not eaſily deſcribed; but, by a detail of its ſeveral parts, ſome idea may be afforded of the whole; and therefore I ſhall diſtinguiſh it into the *cribriform lamella* with its proceſs, the *naſal lamella*, *cellulæ*, and *oſſa ſpongioſa*.

The thin horizontal *lamella*, is all (except its back part) pierced obliquely by a great number of ſmall holes, through which the filaments of the olfactory nerves paſs. In a recent ſubject, theſe holes are ſo cloſely lined by the *dura mater*, that they are much leſs conſpicuous than in the *ſkeleton*.—From the middle of the internal ſide of this plate, a thick proceſs riſes upwards, and, being higheſt at the fore part, gradually becomes lower, as it is extended backwards. From ſome reſemblance which this proceſs was imagined to have to a cock's comb, it has been called *criſta galli* (*l*). The *falx* is connected to its ridge, and to the unperforated part of the cribriform plate.—When the *criſta* is broke, its baſe is ſometimes found to be hollow, with its cavity opening into the noſe (*m*).—Immediately before the higheſt part of this proceſs, is the blind hole of the *frontal* bone, which, as was formerly remarked, is often in a good meaſure formed by a notch in the fore part of the root of the *criſta*.

From the middle of the outer ſurface of the *cribriform lamella*, a thin ſolid plate is extended downwards and forwards, having the ſame common baſe with the *criſta galli*. Generally it is not exactly perpendicular, but is inclined to one ſide or other, and therefore divides the cavity of the noſe unequally. Its inclination to one ſide, and flexure in the middle, is ſometimes ſo great, that it fills up a large ſhare of one of the noſtrils, and has been miſtook for a *polypus* there.—It is thin at its riſe, and rather ſtill thinner

(*l*) Verruca praedura, ſeptum oſſis ſpongioſi.
(*m*) Palſyn Anat. chir. tr. 4. chap. 15.

thinner in its middle; yet afterwards, towards its lower edge, it becomes thicker, that its conjunction with the bones and middle cartilage of the nofe might be firmer.

At a little diftance from each fide of this external procefs, a cellular and fpongy bony fubftance depends from the cribriform plate. The number and figure of the cells in this irregular procefs of each fide, are very uncertain, and not to be reprefented in words; only the cells open into each other, and into the cavity of the nofe: The uppermoft, which are below the aperture of the frontal *finufes*, are formed like funnels.——The outer furface of thefe cells is fmooth and plain, where this bone affifts in compofing the orbit; at which place, on each fide, it has got the name of *os planum*; on the upper edge of which, a fmall notch or two may fometimes be obferved, which go to the formation of the internal orbitar holes; as was remarked in the defcription of the frontal bone.

Below the cells of each fide, a thin plate is extended inwards, and then, bending down, it becomes thick and of a fpongy texture.—This fpongy part is triangular, with a ftraight upper edge placed horizontally, an anterior one flanting from above, downwards and forwards, and with a pendulous convex one below.—The upper and lower edges terminate in a fharp point behind.—The fide of this pendulous fpongy part next to the *feptum narium* is convex, and its external fide is concave.—Thefe two proceffes of the *ethmoid* bone have got the name of *offa fpongiofa*, or *turbinata fuperiora*, from their fubftance, figure, and fituation.

All the prominences, cavities, and *meanders* of this *ethmoid* bone, are covered with a continuation of the membrane of the noftrils, in a recent fubject.—Its horizontal cribriform plate is lodged between the orbitar proceffes of the *frontal* bone, to which it is joined by the *ethmoid* future, except at the back-part, where it is connected with the *cuneiform* bone, by a future common to both thefe bones, though it is generally efteemed part of the *fphenoidal*.—Where the

offa plana are contiguous to the frontal bone within the orbit, their conjunction is reckoned part of the transverse suture.—Farther forward than the *offa plana*, the cells are covered by the *offa unguis*, which are not only contiguous to these cells, but cannot be separated from them, without breaking the bony substance; and therefore, in justice, those bones ought to be demonstrated as part of the *ethmoid* bone.—Below the *offa unguis* and *plana*, these cells and *offa spongiosa* are overlopped by the *maxillary* bones.—The cellular part of each *palate* bone is contiguous to each *os planum* and cells backwards.—The lower edge of the nasal perpendicular plate is received into the furrow of the *vomer*.—Its posterior edge is joined to the fore-part of the *processus azygos* of the *sphenoid* bone.—Its upper edge joines the *nasal* process of the *frontal* and *nasal* bones, and its anterior one is connected to the middle cartilage of the nose.

From all which, the uses of this bone are evident, *viz.* to sustain the anterior lobes of the brain; to give passage to the olfactory nerves, and attachment to the *falx;* to enlarge the organ of smelling, by allowing the membrane of the nose a great extent; to straiten the passage of the air through the nose, by leaving only a narrow winding canal, on the sensible membranous sides of which the substances conveyed along with the air must strike; to form part of the orbit of the eyes and *septum narium*; while all its parts are so light as not to be in hazard of separating by their weight; and they are so thin, as to form a large surface, without occupying much space. This brittle substance, however, is sufficiently protected from external injuries by the firm bones which cover it.

If this bone is seized on by any corroding matter, we may easily conceive what destruction may ensue. Hence it is, that an *ozaena* is difficult to cure; and that, in violent *scurvies*, or in the *lues venerea*, the fabric of the nose, the eyes, and life itself are in danger.—The situation of the nasal plate may shew us

hav

ow dangerous a fracture of the bones of the nofe ıay be, when made by a force applied to their middle ore part, of a perfon in whom this nafal plate is per-endicular.

The *ethmoid* bone of ripe children is divided into wo, by a perpendicular cartilage, which, when offi-ed, is the *crifta galli*, and nafal plate: but its o-her parts are offified and complete.

OS SPHENOIDES *, or wedge-like bone, fo alled becaufe of its fituation in the middle of the ones of the *cranium* and face, is of fuch an irregular gure, that I know not any thing to which it may be kened, unlefs, perhaps, it bear fome faint refem-lance to a bat with its wings extended.

When we view the external furface of the *os fphe-oides*, two or three remarkable proceffes from each de of it may be obferved, which are all of them a-ain fubdivided.—The firft pair is the two large la-eral proceffes or wings; the upper part of each of hich is called the *temporal procefs*, becaufe they join ith the temporal bones in forming the temples, and he feat for fome fhare of the *crotaphite* mufcles. That part of the wings which juts out towards the nfide, fomewhat lower than the temporal *apophyfes*, nd is fmooth and hollowed, where it makes up part f the orbit, is thence named *orbitar proceffes*. Be-ind the edge, feparating thefe two proceffes, there s often a fmall groove, made by a branch of the fu-erior maxillary nerve, in its paffage to the temporal ıufcle. The loweft and back part of each wing, hich runs out fharp to meet the *offa petrofa*, has been tyled the *fpinous* procefs: From near the point of hich a fharp pointed procefs is frequently produced ownwards, which fome call *ftyliform*, that affords rigin to the *ptery-ftaphylinus externus* mufcle. From ıis ftyloid procefs a very fmall groove is extended a-ong the edge of the bone to the hollow at the root f the internal plate of the following proceffes, which forms

* Cuneiforme, πολυμορφον, multiforme, paxillum, cribratum pa-ti, colatorii, cavilla, bafilare.

forms part of the *Euſtachian* tube (*a*).—The ſecond pair of external proceſſes of the *cuneiform* bone is the two which ſtand out almoſt perpendicular to the baſe of the ſcull. Each of them has two plates, and a middle *foſſa* facing backwards, and ſhould, to carry on our compariſon, be likened to the bat's legs, but are commonly ſaid to reſemble the wings of that creature; and therefore are named *pterygoid* or *aliform* * proceſſes. The external plates are broadeſt, and the internal are longeſt. From each ſide of the external plates the *pterygoid* muſcles take their riſe. At the root of each internal plate, a ſmall hollow may be remarked, where the *muſculus ptery-ſtaphylinus internus*, or *circumflexus palati* riſes, and ſome ſhare of the cartilaginous end of the *Euſtachian* tube reſts; and, at the lower end of the ſame plate, is a hook-like riſing or proceſs, round which the tendon of the laſt-named muſcle, plays as on a pulley. From the edge of the external plate ſome ſmall ſharp ſpikes ſtand out; but their number and bulk are uncertain. To theſe another pair may be added, to wit, the little triangular thin proceſs, which comes from each ſide of the body of the *ſphenoid* bone, where the *pterygoid* proceſſes are riſing from it, and are extended over the lower part of the aperture of the *ſinus* as far as to join the *ethmoid* bone, while their body hangs down into the *nares* (*b*).—Beſides theſe pairs of proceſſes, there is a ſharp ridge which ſtands out from the middle of its baſe: Becauſe it wants a fellow, it may be called *proceſſus azygos*. The lower part of this proceſs, where it is received into the *vomer*, is thick, and often not quite perpendicular, but inclining more to one ſide than the other. The fore part of this proceſs, where it joins the naſal plate of the *os ethmoides*, is thin and ſtraight. Theſe two

(*a*) Winſlow Expoſition anatomique du corps humain, traité des os ſecs, § 233.

* Naviculares.

(*b*) Albin. Tab. oſſ. 5. fig 2. 6. A A.—Bertin Mem. de l'acad. des ſciences, 1744.—Sue, planche viii. fig. 2. 3. 4. 5. 6.

two parts have been deſcribed as two diſtinct proceſſes by ſome.

The depreſſions, ſinuoſities, and *foſſae*, on the external ſurface of this *ſphenoid* bone, may be reckoned up to a great number, *viz.* two on the temporal apophyſes where the *crotaphyte* muſcles lodge.—Two on the *orbitar* proceſſes, to make way for the globes of the eyes.—Two between the *temporal* and *ſpinous* proceſſes, for receiving the temporal bones.—Two between the plates of the *pterygoid* proceſſes, where he *muſculi pterygoidei interni* and *ptery-ſtaphylini interni* ire placed.—Two between the *pterygoid* and *orbitar* roceſſes, for forming the holes common to this and o the *cheek* and *maxillary* bones.—Two on the lower nds of the *aliform* proceſſes, which the *palate* bones nter into.—Two at the roots of the *temporal* and *terygoid* proceſſes, where the largeſt ſhare of the exernal *pterygoid* muſcles have their riſe.—Two at the des of the *proceſſus azygos*, for forming part of the oſe, *&c.*

What I deſcribed under the name of *temporal* and *pinous proceſſes* on the outſide of the ſcull, are likeviſe ſeen on its inſide, where they are concave, for eceiving part of the brain; and commonly three *pophyſes* on the internal ſurface of the *ſphenoid* bone re only mentioned. Two riſing broad from the ore-part of its body, become ſmaller as they are exended obliquely backwards.—The third ſtanding on long tranſverſe baſe, near the back-part of the body f this bone, riſes nearly erect, and of an equal readth, terminating often in a little knob on each de. The three are called *clinoid*, from ſome reſemance which they were thought to have to the ſuporters of a bed. Sometimes one or both the anteor *clinoid* proceſſes are joined to the ſides of the poerior one, or the body of the bone itſelf.—From the ots of the anterior *clinoid* proceſſes the bone is exnded on each ſide outwards and forwards, till it ıds in a ſharp point, which may have the name of e *tranſverſe ſpinous* proceſſes.—Between, but a little

farther back than the two anterior *clinoid* proceſſes, we ſee a protuberance conſiderably ſmaller than the poſterior *clinoid* proceſs, but of its ſhape.—Another proceſs from between the tranſverſe proceſſes, often forces itſelf forwards into the *os ethmoides*.

Within the ſcull, there are two ſinuoſities in the internal part of each wing of the *ſphenoid* bone, for receiving the middle part of the brain.—One between the tranſverſe ſpinous proceſſes, for lodging the part of the brain where the *crura medullae oblongatae* are.—Immediately before the third or middle *clinoid* proceſs, a ſingle pit generally may be remarked, from which a *foſſa* goes out on each ſide to the holes through which the optic nerves paſs. The pit is formed by the conjoined optic nerves; and in the *foſſæ* theſe nerves are lodged, as they run divided within the ſcull.—Between that third protuberance and the poſterior *clinoid* proceſs, the larger pit for the *glandula pituitaria* may be remarked. This cavity, becauſe of its reſemblance to a *Turkiſh* ſaddle, is always deſcribed under the name of *ſella Turcica*, or *ephippium*.—On the ſides of the poſterior *clinoid* proceſs, a *foſſa* may be remarked, that ſtretches upwards, then is continued forwards along the ſides of the *ſella Turcica*, near to the anterior *clinoid* proceſſes, where a pit on each ſide is made. Theſe *foſſæ* point out the courſe of the two internal *carotid* arteries, after they have entered the ſcull.—Beſides all theſe, ſeveral other *foſſæ* may be obſerved, leading to the ſeveral holes, and imprinted by the nerves and blood-veſſels.

The holes on each ſide of the *os ſphenoides* are ſix proper, and three common.—The *firſt* is the round one immediately below the anterior *clinoid* proceſſes for the paſſage of the optic nerve, and of the branch of the internal *carotid* artery that is ſent to the eye.—The *ſecond* is the *foramen lacerum*, or large ſlit between the tranſverſe ſpinous and orbitar proceſſes The interior end of which ſlit is large; and, as it is extended outwards, it becomes narrower. The outer end of it is formed in the *os frontis*; and therefore thi

this might be reckoned among the common *foramina*. Through it the third, fourth, the firſt branch of the fifth, and the greater ſhare of the ſixth pair of nerves; and an artery from the internal carotid, go into the orbit. Sometimes a ſmall branch of the external carotid enters near its end, to be diſtributed to the *dura mater* (*a*); and a vein, ſome call it the *venous duct*, or, *Nuck's aquæduct*, returns through it to the cavernous *ſinus*.—The *third* hole, ſituated a little below the one juſt now deſcribed, is called *rotundum*, from its ſhape. It allows paſſage to the ſecond branch of the fifth pair of nerves, or ſuperior maxillary nerve, into the bottom of the orbit. The *fourth* is the *foramen ovale*, about half an inch behind the round hole. Through it the third branch of the fifth pair, or inferior *maxillary* nerve, goes out; and ſometimes a vein from the *dura mater* paſſes out here (*b*).—Very near the point of the ſpinous proceſs is the *fifth* hole of this bone: It is ſmall and round, for a paſſage to the largeſt artery of the *dura mater*, which often is accompanied with a vein. The *ſixth* proper hole (*c*) cannot be well ſeen, till the cuneiform bone is ſeparated from all the other bones of the *cranium*; for one end of it is hid by a ſmall protuberance of the internal plate of the *pterygoid* proceſs, and by the point of the *proceſſus petroſus* of the *temporal* bone. Its canal is extended above the inner plate of the *pterygoid* proceſs; and where it opens into the cavity of the noſe, it is concealed by the thin laminous part of the *palate* bone. Through it a conſiderable branch of the ſecond branch of the *fifth* pair of nerves is reflected.—Often in the middle of the *ſella Turcica* a ſmall hole or two pierce as far as the cellular ſubſtance of the bone; and ſometimes at the ſides of this *ſella*, one or more ſmall holes penetrate into the *ſphenoidal* *ſinuſes*.

(*a*) Winſlow Expoſition anatomique du corps humain, traité des arteries, § 60. et de la tete, § 26.

(*b*) Ingraſſ. Commentar. in Galen. de oſſib. lib. 1. comment. 8.

(*c*) Veſal. Anat. lib. 1. cap. 12.—Euſtach. tab. 46. fig. 13. & 16.—Vidus Vidius Anat. lib. 2. cap. 2. explicat. tab. 5. & tab. 5. fig. 8. 9. 10. lit. O.

ſinuſes. Theſe obſervations afforded ſome anatomiſts (*a*) an argument of weight in their days in defence of *Galen* (*b*), who aſſerted the deſcent of the *pituita* that way into the *ſinuſes* below.

The *firſt* of the common holes is that unequal fiſſure at the ſide of the *ſella Turcica*, between the extreme point of the *os petroſum* and the *ſpinous* proceſs of the cuneiform bone. This hole only appears after the bones are boiled; for in a recent ſubject its back part is covered by a thin bony plate that lies over the internal carotid artery, and further forward it is filled with a cartilaginous ligament, under which the cartilaginous part of the *Euſtachian tube* is placed: It was by this paſſage that the ancients believed the *ſlimy matter* was conveyed from the eumunctory of the brain, the *glandula pituitaria*, to the *fauces*.—The *ſecond* common hole is the large diſcontinuation of the external ſide of the orbit, left between the orbitar proceſſes of the cuneiform bone, the *os maxillare*, *malæ*, and *palati*. In this large hole the fat for lubricating the globe of the eye and temporal muſcle is lodged, and branches of the ſuperior maxillary nerve, with ſmall ateries from the carotid and veins paſs.—The *third* hole is formed between the baſe of this bone and the root of the orbitar proceſs of the palate bone of each ſide. Through this a branch of the external carotid artery, and of the ſecond branch of the fifth pair of nerves, are allowed a paſſage to the noſtrils, and a returning vein accompanies them. Sometimes, however, this hole is proper to the palate bone, being entirely formed out of its ſubſtance.

Under the *ſella Turcica*, and ſome way farther forward, but within the ſubſtance of the *ſphenoid* bone, are two *ſinuſes*, ſeparated by a bony plate. Each of them is lined with a membrane, and opens into the upper and back-part of each noſtril by a round hole, which is at their upper fore-part. This hole is not formed

(*a*) Jac. Sylv. Calumniæ ſecundæ amolitio.—Laurent. Hiſt. anat. lib. 2. queſt. 11.

(*b*) Galen De uſu part. lib. 9. cap. 1.

formed only by the *os ſphenoides*, which has an aperture near as large as any tranſverſe ſection of the *ſinus*, but alſo by the *palate* bones which are applied to the fore-part of theſe *ſinuſes*, and cloſe them up, that hole only excepted, which was already mentioned. Frequently the two *ſinuſes* are of unequal dimenſions, and ſometimes there is only one large cavity, with an opening into one noſtril. Theſe cavities are likewiſe ſaid (*a*) to be extended ſometimes as far back as the great *foramen* of the occipital bone. In other ſubjects they are not to be found, when the bone is compoſed of large cells (*b*). Some (*c*) mention a cavity within the partition of the *ſinuſes*; but it is ſmall. —The *ſphenoidal ſinuſes* ſerve the ſame uſes as the frontal do.

As this bone is extremely ragged and unequal, ſo its ſubſtance is of very different thickneſs, being in ſome places diaphanous; in others it is of a middle thickneſs, and its middle back-part ſurpaſſes the greateſt ſhare of the *cranium* in thickneſs.

The *os ſphenoides* is joined, by its wings, to the *parietal* bones above, to the *os frontis* and *oſſa malarum* before, to the *temporal* bones behind;—by the fore-part of its body and ſpinous proceſſes, to the *frontal* and *ethmoid* bones;—by its back-part, behind the two *ſinuſes*, to the *occipital*, where it looks like a bone with the *epiphyſes* taken off, and, as was formerly obſerved in the deſcription of the occipital bone, it cannot be ſeparated without violence in adults;—to the *palate* bones, by the ends of the *pterygoïd* proceſſes, and ſtill more by the fore-part of the internal plates of the *pterygoïd* proceſſes, and of the *ſinuſes*;—to the *maxillary* bones, by the fore-part of the external *pterygoid* plates;—to the *vomer* and naſal plate of the *os ethmoides*, by the *proceſſus azygos*. All theſe conjunctions, except the laſt, which is a *ſchyndeleſis*, are ſaid to be by the ſuture proper to this bone; though it is at firſt ſight evident,

 that

(*a*) Albin. de oſſib. § 39.
(*b*) Veſal. lib. 1. cap. 6.
(*c*) Id. ibid.

that ſeveral other ſutures, as the *tranſverſe, ethmoidal, &c.* are confounded with it.

We ſee now how this bone is joined to all the bones of the *cranium*, and to moſt of the upper jaw; and therefore obtained the name of the *wedge-like bone.*

The uſes are ſo blended with the deſcription, as to leave nothing new to be added concerning them.

The *ſphenoidal* bone is almoſt compleat in a *fœtus* of ninth months; only the great *alæ* ſeparate after maceration from the body of the bone.—The *proceſſus azygos* is very large and hollow;—the thin triangular proceſſes are not oſſified;—the internal ſurface of the body is unequal and porous;—the *ſinuſes* do not appear.

Whoever is acquainted with each bone of the *cranium*, can, without difficulty, examine them as they ſtand united, ſo as to know the ſhapes, ſizes, diſtances, *&c.* of their ſeveral parts, and the forms, capacities, *&c.* of the cavities formed by them, which is of great uſe towards underſtanding the anatomy of the parts contiguous to, contained within, or connected to them. Such a review is neceſſary, after conſidering each claſs of bones. Thus the orbits, noſtrils, mouth, face, head, ſpine, *thorax, pelvis*, trunk, extremities, and ſkeleton, ought likewiſe to be examined.

The *FACE* is the irregular pile of bones, compoſing the fore and under part of the head, which is divided, by authors, into the upper and lower *maxillæ* or jaws.

The *ſuperior maxilla* (*d*) is the common deſignation given to the upper immoveable ſhare of the face; though, if we would follow *Celſus* (*e*), we ſhould apply the word *maxilla* to the lower jaw only, and the name *mala* to this upper jaw. In complaiſance to prevailing cuſtom, I ſhall, however, uſe the terms as now commonly employed. The ſhape of the ſuperior jaw cannot eaſily be expreſſed; nor is it neceſſary;

(*d*) Σιαγων, γενος, mandibula.
(*e*) Lib. 8. cap. 1.

ry, provided the ſhape and ſituation of all the bones which compoſe it are deſcribed. It is bounded above by the tranſverſe ſuture, behind by the fore-part of the *ſphenoid* bone, and below by the mouth.

The upper jaw conſiſts of ſix bones on each ſide, of a thirteenth bone which has no fellow, placed in the middle, and of ſixteen teeth. The thirteen bones are, two *oſſa naſi*, two *oſſa unguis*, two *oſſa malarum*, two *oſſa maxillaria*, two *oſſa palati*, two *oſſa ſpongioſa inferiora*, and the *vomer*.

The *oſſa naſi* are placed at the upper part of the noſe;—the *oſſa unguis* are at the internal *canthi* of the orbits;—*oſſa malarum* form the prominence of the cheeks;—*oſſa maxillaria* form the ſide of the noſe, with the whole lower and fore-part of the upper jaw, and the greateſt ſhare of the roof of the mouth;—*oſſa palati* are ſituated at the back-part of the palate, noſtrils, and orbit;—*oſſa ſpongioſa* are ſeen in the lower part of the *nares*;—and the *vomer* helps to ſeparate theſe two cavities.

The bones of the *upper jaw* are joined to the bones of the ſcull by the *ſchyndeleſis* and ſutures already deſcribed as common to the *cranium* and *face*, and they are connected to each other by *gomphoſis* and fifteen ſutures.

The *gomphoſis* only is where the teeth are fixed in their ſockets, and the *ſchyndeleſis* is only where the edges of the *vomer* are joined to other bones.

The ſutures are generally diſtinguiſhed by numbers, which have been differently applied; and therefore I join thoſe *(f)* who prefer the giving names to each, which may be eaſily contrived from their ſituation, or from the bones which they connect.

The firſt is the *anterior naſal* (*g*), which is ſtraight, and placed longitudinally in the middle fore-part of the noſe.

The

(f) Vander Linden. Medicin. phyſiolog. cap. 13. art. 2. ſect. 10. —Rolfinc. Anat. lib. 2. cap. 25.—Schenk. Schol. part. ſect. ult. par. 2. cap. 5.

(*g*) Naſalis recta.

The ſecond and third are the *lateral naſal* (*h*), which are at each ſide of the noſe, and almoſt parallel to the firſt ſuture.

Each of the two *lacrymal* is almoſt ſemicircular, and is placed round the *lacrymal* groove.

The ſixth and ſeventh are the *internal orbitar* : each of which is extended obliquely from the middle of the lower ſide of an orbit to the edge of its baſe.

The two *external orbitars* are continued, each from the end of the internal orbitar, to the under and fore-part of the cheek.

The tenth is the *myſtachial*, which reaches only from the lower part of the *ſeptum narium* to between the two middle *dentes inciſores*.

The *longitudinal palate* (*i*) ſuture ſtretches from the middle of the foremoſt teeth through the middle of all the palate.

The *tranſverſe palate* one (*k*) runs acroſs the palate, nearer the back than the fore-part of it.

Each of the two *palato-maxillary* is at the back part of the ſide of each noſtril.

The fifteenth is the *ſpinous*, which is in the middle of the lower part of the noſtrils. This may perhaps be rather thought a double *ſchyndeleſis*.

The connection of the *oſſa ſpongioſa* to the ſide of each noſtril, is ſo much by a membrane in young ſubjects, by a ſort of hook, and afterwards by concretion or union of ſubſtance in adults, that I did not know well how to rank it : But if any chooſes to call it a ſuture, the addition of two *tranſverſe naſal* ſutures may be made to thoſe above named.

Theſe ſutures of the face (formerly called *harmoniæ*) have not ſuch conſpicuous indentations as thoſe of the ſcull have ; the bones here not having ſubſtance enough for forming large indentations, and there being leſs neceſſity for ſecurity againſt external injuries, or any internal protruding force, than in the *cranium*.—

(*h*) Naſalis obliqua.

(*i*) Laquearis, palataria recta.

(*k*) Arcuata, palatina poſtica.

cranium.—These sutures often disapear in old people, by the bones running into each other; which can do little prejudice, because the principal use of the bones being so numerous here, is to allow them to be extended into a proper form.

It is evident, from the manner of the conjunction of these bones, that they can have no motion, except in common with the *cranium*.

The purposes which this pile of bones serves, will be shewn in the description which I am to give of each of them.

OSSA NASI, so named from their situation at the root of the nose, are each of an irregular oblong square figure, being broadest at their lower end, narrowest a little higher than their middle, and becoming somewhat larger at the top, where they are ragged and thickest, and have a curvature forwards, that their connection with the *frontal* bone might be stronger.—These bones are convex externally, and thereby better resist any violence from without; and they are concave internally, for enlarging the cavity of the nose.

The lower edge of these bones is unequal, and is stretched outwards and backwards, to join the cartilages of the nostrils.—Their anterior side is thick, especially above, and unequal, that their conjunction to each other might be stronger; and a small rising may be remarked on their inner edge, where they are sustained by the *septum narium*.—Their posterior side, at its upper half, has externally a depression, where it is overlopped some way by the *maxillary* bones, while its lower half covers these bones: By which contrivance, they do not yield easily to pressure applied to their fore-part or sides.

A small hole is frequently to be observed on their external surface, into which two, three, or four holes, which appear internally, terminate for the transmission of small veins; sometimes the holes go no further than the *cancelli* of the bones.

The

The *nasal bones* are firm and solid, with very few *cells* or *cancelli* in them; the thin substance of which they consist, not requiring much marrow.

They are joined above the *frontal* bone, by the middle of the *transverse* suture;—behind, to the *maxillary* bones, by the *lateral nasal* sutures;—below, to the cartilages of the nose;—before, to one another, by the *anterior nasal* suture;—internally, to the *septum narium*.

These bones serve to cover and defend the root of the nose.

In an infant the *nasal bones* are proportionally shorter, and less thick at their upper part, than in an adult, but are otherwise compleat.

OSSA UNGUIS, or *LACRYMALIA*, are so named, because their figure and magnitude are something near to those of a nail of one's finger, and because the tears pass upon them into the nose.

Their external surface is composed of two smooth concavities and a middle ridge.—The depression behind forms a small share of the orbit for the eye-ball to move on, and the one before is a deep perpendicular canal, or *fossa*, larger above than below, containing part of the lacrymal *sac* and *duct*. This is the part that ought to be pierced in the great operation for the *fistula lacrymalis*.—This *fossa* of the bone is cribriform, or has a great number of small holes through it, that the filaments from the membrane which lines it, insinuating themselves into these holes might prevent a separation of the membrane, and secure the bone in its natural situation.—The ridge between these two cavities of the *os unguis*, is the proper boundary of the orbit at its internal *canthus*; and beyond which surgeons should not proceed backwards in performing operations here.—The internal or posterior surface of this bone consists of a furrow in the middle of two convexities.

The substance of the *os unguis* is as thin as paper and very brittle; which is the reason that these bones

ar-

re often wanting in ſkeletons, and need little force o pierce them in living ſubjects.

Each of theſe bones is joined, above, to the *frontal* bone, by part of the *tranſverſe* ſuture;—behind, to he *os planum* of the *ethmoid* bone, by the ſame ſuure;—before, and below, to the *maxillary* bone, by he *lacrymal* ſuture;—internally, the *oſſa unguis* cover ome of the *ſinus ethmoidales*; nay, are really contiuous with the bony *lamellæ* which make up the ſides f theſe cells; ſo that they are as much part of the *thmoid* bone as the *oſſa plana*.

Theſe unguiform bones compoſe the anterior internal parts of the orbits, lodge a ſhare of the lacrynal ſac and duct, and cover the *ethmoid* cells.—Their ituation and tender ſubſtance make a raſh operator n danger of deſtroying a conſiderable ſhare of the organ of ſmelling, when he is performing the operation f the *fiſtula lacrymalis*; but when theſe bones are urt, they caſt off without much difficulty, and conequently the wound is ſoon cured, unleſs the patient abours under a general *cacoethes*, or there is a prediſoſition in the bones to *caries*; in which caſe, a large rain of bad ſymptoms follow, or, at beſt, the cure roves tedious.

Theſe bones are fully formed in a new-born child.

OSSA MALARUM (c) was the name given by *elſus*, as was already remarked, to all the upper jaw; ut is now appropriated to the prominent ſquare bones which form the cheek on each ſide.—Before, their urface is convex and ſmooth; backward, it is uneual and concave, for lodging part of the *crotaphyte* uſcles.

The four angles of each of theſe bones have been eckoned proceſſes by ſome.—The one at the external *anthus* of the orbit, called the *ſuperior orbitar* proceſs, the longeſt and thickeſt.—The ſecond terminates ear the middle of the lower edge of the orbit in a arp point, and is named the *inferior orbitar* proceſs. —The third, placed near the lower part of the cheek, and

(c) Jugalia vel zygomatica, hypopia, ſubocularia.

and thence called *maxillary*, is the ſhorteſt, and neareſt to a right angle.—The fourth, which is called *zygomatic*, becauſe it is extended backwards to the *zygoma* of the temporal bone, ends in a point, and has one ſide ſtraight, and the other ſloping.—Between the two orbitar angles there is a concave arch, which makes about a third of the external circumference of the orbit, from which a fifth proceſs is extended backwards within the orbit, to form near one third of that cavity; and hence it may be called the *internal orbitar* proceſs.—From the lower edge of each of the *oſſa malarum*, which is between the maxillary and zygomatic proceſſes, the *maſſeter* muſcle takes its origin; and from the exterior part of the *zygomatic* proceſs, the *muſculus diſtortor oris* riſes; in both which places the ſurface of the bone is rough.

On the external ſurface of each cheek-bone, one or more ſmall holes are commonly found, for the tranſmiſſion of ſmall nerves or blood-veſſels from, and ſometimes into the orbit.—On the internal ſurface are the holes for the paſſage of the nutricious veſſels of theſe bones.—A notch on the outſide of the *internal orbitar* proceſs of each of theſe bones, aſſiſts to form the great ſlit common to this bone and to the ſphenoid, maxillary, and palate bones.

The ſubſtance of theſe bones is, in proportion to their bulk, thick, hard, and ſolid, with ſome *cancelli*.

Each of the *oſſa malarum* is joined, by its ſuperior and internal orbitar proceſſes, to the *os frontis*, and to the orbitar proceſs of the *ſphenoid* bone, by the *tranſverſe* ſuture.—By the edge between the internal and inferior orbitar proceſſes, to the *maxillary* bone, by the *internal orbitar* ſuture.—By the ſide between the maxillary and inferior orbitar proceſs, again to the maxillary bone, by the *external orbitar* ſuture.—By the zygomatic proceſs, to the *os temporum*, by the *zygomatic* ſuture.

The cheek-bones are entire, and fully oſſified in all their parts in infants.

OSSA

OSSA MAXILLARIA SUPERIORA, are the argeſt bones, and conſtitute the far greater part of he upper jaw, which has appropriated the name of *iaxillaria* to them. The figure of one of them, or f the two when joined, is ſo irregular, that words an ſcarce give an idea of it.

The proceſſes of each *os maxillare* may be reckon-d ſeven.—The *firſt* is the long naſal one at its upper nd fore-part, which is broad below, and turns naller, as it riſes upwards, to make the ſide of the oſe.—At the root of this, a tranſverſe ridge may be bſerved within the noſtrils, which ſupports the fore-art of the upper edge of the *os ſpongioſum inferius.*—'he *ſecond* is produced backwards and outwards, from ıe root of the naſal proceſs, to form the lower ſide f the orbit, and therefore may be called *orbitar.*—'he edge of this orbitar proceſs, and the ridge of ıe naſal one, which is continued from it, make a ɔnſiderable portion of the external circumference of ıe orbit.—From the proper orbitar proceſs, a very ugh triangular ſurface is extended downwards and ıtwards, to be connected to the cheek-bone; and erefore may be called the *malar* proceſs, from the weſt protuberant part of which ſome ſhare of the aſſeter muſcle takes its riſe.—Behind the orbitar oceſs, a large tuberoſity or bulge of the bone ap-ars, which is eſteemed the *fourth* proceſs.—On the ternal part of this we often meet with a ridge, al-oſt of the ſame height with that in the naſal pro-ſs, which runs tranſverſely, and is covered by a nilar ridge of the *palate* bone, on which the back-rt of the upper edge of the *os ſpongioſum inferius* ts.—The convex back-part of this tuberoſity is ıgh for the origin of part of the external *pterygoid* ıſcle (*a*), and more internally is ſcabrous, where e palate and ſphenoid bones are joined to it.—hat ſpongy protuberance (*b*) at the lower circum-ence of this bone, where the ſockets for the teeth

 are

(*a*) Albin. de oſſib. § 79.
(*b*) Φατνια.

are formed, is reckoned the *fifth*.—-The *fixth* is the horizontal plate, which forms the greater part of the bafe of the noftrils, and roof of the mouth; its upper furface, which belongs to the noftrils, is very fmooth, but the other below is arched and rough, for the ftronger adhefion of the membrane of the mouth, which is ftretched upon it, and in chewing, fpeaking, &c. might otherwife be liable to be feparated.—The *feventh* rifes like a fpine from the inner edge of the laft, and forms a fmall part of the partition of the noftrils.

The depreffions in each *maxillary* bone are, 1. A finuofity behind the orbitar procefs, made by the *temporal* mufcle. 2. A pit immediately before the fame procefs, where the origin of the *mufculus elevator labiorum communis*, and *elevator labii fuperioris*, with a branch of the fifth pair of nerves, are lodged fecurely. 3. The hollow arch of the palate. 4. The femicircular great notch, or entry to the lower part of the noftrils, betwixt the root of the nafal procefs and fpine of the palate-plate.—Below this, the fore-part of the bone is flatted, or fometimes hollowed by the *mufculus depreffor labii fuperioris*. 5. Sockets for the teeth (*c*): The number of thefe fockets is uncertain for the fame number of teeth is not in all people and the four backmoft teeth of each fide of each jaw vary greatly in their number of roots; and when the teeth of a living perfon fall out, or are taken away the fockets fill up with an offeous net-work, which becomes folid afterwards. 6. The *lacrymal foffa* in the *nafal procefs*, which affifts the *os unguis* to form a paffage for the *lacrymal duct*. This part of the bone forming this *foffa*, is fo firm and ftrong, that a furgeon fcarce can perforate it with the ordinary inftrument for the *fiftula lacrymalis*, and therefore ought to avoid it in doing this operation.—Immediately on the outfide of this, there is a fmall depreffion, from which the inferior or leffer oblique mufcle of the eye has its origi-

(*c*) Βοθρια, ὀλμισκοι, alveoli, foffulæ, mortariola, fræna, locelli, væ, pralfepiola, loculamenta.

origin (*d*). 7. The canal on the upper part of the great tuberofity within the orbit, which is almoft a complete hole; in this a branch of the fuperior maxillary nerve paffes.—Befides thefe, the fuperior furface of the great bulge is concave, to receive the under part of the eye.—Immediately above the tranfverfe ridge in the nafal procefs, a fmall hollow is formed by the *os fpongiofum*.—In fome fubjects, the nafal procefs has a fmall round pit above the lacrymal duct, where the little tendon or ligament of the orbicular mufcle of the eye-lids is inferted. It is this tendon, and not the tendon of the larger oblique mufcle of the eye, which there is fome hazard of cutting in the operation of the *fiftula lacrymalis*.

The holes of this bone are, two proper and two common, which are always to be found; befides feveral others, whofe magnitude, number, *&c.* are uncertain.—The firft of the proper is the *external orbitar*, immediately below the orbit, by which the infra-orbitar branch of the fecond branch of the fifth pair of nerves, and a fmall artery, come out, after having paffed in the canal, at the bottom of the orbit, defcribed *numb.* 7. of the depreffions.—This hole is often double, and that when the nerve has happened to fplit before it has efcaped from the bone.—The fecond is the *foramen incifivum*, juft behind the fore-teeth, which, at its under part, is one irregular hole common to both the *maxillary* bones when they are joined; but, as it afcends, foon divides into two, three, or fometimes more holes: fome of which open into each noftril. Through them fmall arteries and veins, and a twig of the fecond branch of the fifth pair of nerves pafs, and make a communication between, or join the lining coats of the nofe and mouth. In fome fubjects *Steno*'s duct may be traced fome way on the fide of thefe paffages next to the nofe, and fmall orifices may be obferved opening into the mouth.

(*d*) Winflow Expofition anatomique des os fecs, § 276.

The firſt common hole is that which appears at the inner ſide of the back-part of the *tuberoſity* and of the ſockets of the teeth, and is formed by a *foſſa* in this bone, and a correſponding one in the *os palati:* through it a nerve, which is a branch of the ſecond branch of the fifth pair, runs to the palate.—The other common hole is the great ſlit in the outſide of the orbit deſcribed already, as the ſecond common hole of the ſphenoid bone.

On the naſal proceſs often holes may be obſerved for the paſſage of veſſels to the ſubſtance of the bones; and, at the back-part of each tuberoſity, ſeveral *foramina* are placed, for the tranſmiſſion of nerves to the cavity within: but theſe are uncertain.

All the body of the *maxillary* bone is hollow, and leaves a large *ſinus* akin to the *frontal* and *ſphenoid*, which is commonly, but unjuſtly called *antrum Highmorianum* (*e*). When the *os maxillare* is ſingle, or ſeparated from all the other bones of a ſkeleton, its *antrum* appears to have a large aperture into the noſtrils; but, in a recent ſubject, it is ſo covered at its back-part, by the *palate* bone; in the middle, by the *os ſpongioſum inferius;* before, by a ſtrong membrane, that one, or ſometimes two holes, ſcarce larger than a crow-quill, are only left at the upper part; which, after a ſhort winding progreſs, open into the noſtrils between the two *oſſa ſpongioſa*.—At the bottom of this cavity, we may often obſerve ſome protuberances, in which the ſmall points of the roots of the teeth are contained (*f*).—This cavern and the ſockets of the teeth are often divided by the interpoſition only of a very thin bony plate, which is liable to be eroded by acrid matter collected in the *antrum*, or to be broke in drawing a tooth (*g*). The ſymptoms of a collection of matter here, naturally led us to the practice of pulling out the teeth, and piercing through this plate into the *antrum*, to procure an evacuation

(*e*) Genæ.
(*f*) Highmore Diſquiſ. anat. lib. 3. par. 2. cap. 1.

vacuation of the collected matter; by which confiderable fervice is frequently done (*h*).

The *maxillary finufes* have the fame ufes as the *frontal* and *fphenoidal;* and the fituation of the *finufes* is fuch, that the liquor drilling from them, from the cells of the ethmoid and palate bones, and from the lacrymal ducts, may always moiften all the parts of the membrane of the *nares* in the different fituations which the head is in.

Though the membranes which line the *frontal, fphenoidal,* and *maxillary finufes,* are continuations of the one which covers the bones within the nofe; yet they are much thinner than it is, and have fo much fmaller veffels, that the injection which makes the membrane of the nofe red all over, fills only fome few veffels of the *maxillary finufes,* and fcarce is obferved in the *frontal* and *fphenoidal.* Are not the larger veffels intended for a more plentiful fecretion of a vifcid liquor to defend the membrane from the effects of the *perflatus,* which is conftantly through the nofe? Are not the membranes which have the fmalleft veffels, *cæteris paribus,* the moft fenfible? Are not many phænomena of fmelling, inflammations of thefe parts, *megrim, polypi, &c.* depending on this ftructure of thefe membranes?

The fubftance of the *offa maxillaria* is compact and firm, except at the inferior proceffes, in which the teeth are lodged, where it is very fpongy.

The *maxillary* bones are joined above by the upper ends of their nafal proceffes to the *os frontis,* by the *tranfverfe* future;—at the fides of thefe proceffes, to the *offa unguis,* by the *lacrymal* futures;—to the *nafal* bones, by the *lateral nafal* futures;—by their orbitar proceffes, to the *cheek* bones, by the *external orbitar* futures;—by the internal fides of the internal orbitar proceffes, to the *offa plana,* by part of the *ethmoidal* future;—by the back-part of the tuberofities, to the *palate* bones, by the *futuræ palato-maxillares;*—by the

 pofterior

(*h*) Cowper in Drake's anthropol. book 3. chap. 10.—Medical Effays and obferv. vol. 5. art. 30.

poſterior edges of their palatine *lamellæ*, to the *oſſa palati*, by the *tranſverſe* palate ſuture;—by their naſal *ſpines* to the *vomer*, by the *ſpinous* ſuture;—by their ſockets, to the teeth, by *gomphoſis*;—by the internal edge of the palate-plate, to one another, by the *longitudinal* palate ſuture; on the upper and fore-part of which a furrow is left for receiving the cartilage which forms the partition of the noſtrils;—between the fore-part of the noſtrils and mouth, to each other, by the *myſtachial* ſuture;—ſometimes they are connected to the *oſſa ſpongioſa inferiora*, by a plain concretion or union of ſubſtance.

Theſe bones form the greater part of the noſe and of the roof of the mouth, and a conſiderable ſhare of the orbit. They contain ſixteen teeth, give riſe to muſcles, tranſmiſſion to nerves, &c. as mentioned in the deſcription of their ſeveral parts.

In each of the *maxillary* bones of a new-born child, the external orbitar proceſs is hollow, with remarkable holes in it;—there are five ſockets for the teeth, of which the two poſterior are very large, and, when divided by a ſecond croſs partition, make the number of ſockets ſix (*i*).—The palate-plate is cribriform about the middle.—The great tuberoſity is not formed;—inſtead of the *antrum*, there is only an oblong depreſſion at the ſide of the noſtrils.

OSSA PALATI are commonly deſcribed as two ſmall ſquare bones, at the back-part of the palate or roof of the mouth, though they are of much greater extent, being continued up the back-part of the noſtrils to the orbit (*k*). Each palate-bone may therefore be divided into four parts, the palate ſquare bone, the pterygoid proceſs, naſal *lamella*, and orbitar proceſs.

The

(*i*) Albin. Oſteologen. tab. 5. fig. 45.—Ungebav. de dentit. ſecund. jun. § 1.

(*k*) Euſtach. tab. 47. fig. 1, 3, 6, 7, 8.—Vidus Vidius de Anat. lib. 2. cap. 2. explicat. tab. 6. fig. 19.—Winſlow Memoires de l'acad. des ſciences, 1720.

The ſquare-bone is unequally concave, for enlarging both the mouth and cavity of the noſe. The upper part of its internal edge riſes in a ſpine, after the ſame manner as the palate-plate of the *maxillary* bone does, to be joined with the *vomer*.—Its anterior edge is unequally ragged, for its firmer connection with the palate proceſs of the *os maxillare*.—The internal edge is thicker than the reſt, and of an equal ſurface, for its conjunction with its fellow of the other ſide.—Behind, this bone is ſomewhat in form of a creſcent, and thick, for the firm connection of the *velum pendulum palati;* the internal point being produced backwards, to afford origin to the *palato-ſtaphylinus* or *azygos* muſcle.—This ſquare bone is well diſtinguiſhed from the *pterygoid* proceſs by a perpendicular *foſſa*, which, applied to ſuch another in the *maxillary* bone, forms a paſſage for the palatine branch of the fifth pair of nerves; and by another ſmall hole behind this, through which a twig of the ſame nerve paſſes.

The *pterygoid* proceſs is ſomewhat triangular, having a broad baſe, and ending ſmaller above. The back-part of this proceſs has three *foſſæ* formed in it; the two lateral receive the ends of the two plates of the ſphenoid bone, that are commonly compared to a bat's wing; the middle *foſſa* makes up a part of what is commonly called the *foſſa pterygoidea*; the fore-ſide of this palatine pterygoid proceſs is an irregular concave, where it receives the back-part of the great *tuberoſity* of the *maxillary* bone.—Frequently ſeveral ſmall holes may be obſerved in this triangular proceſs, particularly one near the middle of its baſe, which a little above communicates with the common and proper holes of this bone already taken notice of.

The *naſal lamella* of this bone is extremely thin and brittle, and riſes upwards from the upper ſide of the external edge of the ſquare bone, and from the narrow extremity of the *pterygoid* proceſs; where it is ſo weak, and, at the ſame time, ſo firmly fixed to the

the *maxillary* bone, as to be very liable to be broken in ſeparating the bones.—From the part where the plate riſes, it runs up broad on the inſide of the *tuberoſity* of the *maxillary* bone, to form a conſiderable ſhare of the ſides of the *maxillary ſinus*, and to cloſe up the ſpace between the *ſphenoid* and the great bulge of the maxillary bone, where there would otherwiſe be a large ſlit opening into the noſtrils (*l*). From the middle internal ſide of this thin plate, a croſs-ridge placed on ſuch another of the maxillary bone is extended; on it, the back-part of the *os ſpongioſum inferius* reſts.—Along the outſide of this plate, the perpendicular *foſſa* made by the palate nerve is obſervable.

At the upper part of this naſal plate, the palate-bone divides into two proceſſes, which I already named *orbitar*;—between which and the body of the *ſphenoid* bone, that hole is formed, which I mentioned as the laſt of the holes common to the *ſphenoid* bone.—Sometimes this hole is wholly formed in the *os palati*, by a croſs plate going from the one orbitar proceſs to the other. A nerve, artery, and vein belonging to the noſtrils paſs here.—The anterior of the two orbitar proceſſes is the largeſt, and has its fore-part contiguous to the back-part of the *maxillary ſinus*, and its upper ſurface appears in the bottom of the orbit, behind the back-part of the *os maxillare* and *planum*.—It has cells behind, reſembling thoſe of the *ethmoid* bone, to which it is contiguous; it is placed on the aperture of the *ſinus ſphenoidalis*, ſo as to leave only a round hole at its upper fore-part.—The other part of the orbitar proceſs is extended along the internal ſide of the upper back-part of the maxillary *tuberoſity*, to the baſe of the *ſphenoid* bone, between the root of the *proceſſus azygos* and the pterygoid proceſs.

The palate ſquare part of this palate-bone, and its pterygoid proceſs, are firm and ſtrong, with ſome *cancelli*;

(*l*) Albin. de oſſib. § 88.

ancelli; but the nafal plate and orbitar proceffes are very thin and brittle.

The palate-bones are joined to the *maxillary*, by the fore-edge of the palate fquare-bone, by the *tranfverfe palate* future:—By their thin nafal plates, and part of their orbitar proceffes, to the fame bones, by the *palato-maxillares* futures:—By their *pterygoid* proceffes, and back-part of the *nafal plates*, to the *alæ vefpertilionum*, by the *fphenoid* future:—By the tranfverfe ridges of the nafal plates, to the *offa fpongiofa inferiora*, by contact; hence frequently there is an intimate union of the fubftance of thefe bones in old fculls:—By the orbitar proceffes, to the *offa plana* and *cellulæ ethmoideæ*, by the *ethmoid* future:—To the body of the *fphenoid* bone by the *fphenoid* future:—By the internal edge of the fquare bones, to each other, by the *longitudinal* palate future; and by their nafal fpines, to the *vomer*, by the *fpinous* future.

The palate-bones form part of the palate, noftrils, orbits, and *foffæ pterygoideæ*, and they cover part of the *finus maxillares*, *fphenoidales*, and *ethmoidei*.

Thefe bones are very complete in a new-born infant, the nafal plates being then thicker and ftronger than in adults; but the orbitar proceffes have not the cells which appear in the bones of adults.

When we are acquainted with the hiftory of thefe bones, the reafon is evident, why the eyes are fo much affected in ulcers of the palate, as to be often attended with blindnefs, which frequently happens in an ill-managed *lues venerea;* or why, on the other hand, the palate fuffers from an *ægylops* (*m*).

OSSA TURBINATA, or *fpongiofa inferiora*, refemble the fuperior *offa fpongiofa* in fhape and fubftance, but have their anterior and upper edges contiguous to the tranfverfe ridges of the nafal proceffes of the *maxillary* and *palate bones*.—From their upper ftraight edge, two fmall proceffes ftand out: the pofterior, which is the broadeft, defcends to cover fome of the *antrum Highmorianum;* the anterior rifes up to join

(*m*) Hoffman in Ephemerid. German. cent. 1. and 2. obferv. 135.

join the *os unguis*, and to make part of the *lacrymal duct*.

Below the ſpongy bones already mentioned, there are ſometimes two others, one in each noſtril, which ſeem to be a production of the ſides of the maxillary *ſinus* turned downwards (*n*). When this third ſort of ſpongy bones is found, the middle one of the three in each noſtril is the largeſt, and the loweſt is the ſmalleſt.—Beſides all theſe, there are often ſeveral other ſmall bones ſtanding out into the noſtrils, that, from their ſhape, might alſo deſerve the name of *turbinata*, but are uncertain in their bulk, ſituation, and number (*o*).

The names of theſe bones ſufficiently declare their ſpongy ſubſtance, which has no firm external plate covering it.

They are joined to the *oſſa maxillaria palati*, and *unguis* in old ſubjects, by a firm union of ſubſtance: And as this happens alſo frequently in people of no great age, ſome (*p*) are of opinion, that they ſhould be eſteemed part of the palate-bones; others (*q*) think, that ſince their upper edge is continued by a plate to a part of the *os ethmoides*, they ought to be eſteemed to be a part of this bone.

Their uſe is, to ſtraiten the noſtrils, to afford a large ſurface for extending the organ of ſmelling, to cover part of the *antra maxillaria*, and to aſſiſt in forming the under part of the lacrymal ducts, the orifices of which into the noſe are concealed by theſe bones.

The *oſſa turbinata* are nearly complete in a new-born infant.

VOMER, or bone reſembling a plough-ſhare, is the thirteenth of the upper jaw, without a fellow forming the lower and back parts of the partition of the noſe (*r*).

The

(*n*) Cowper in Drake's Anthropolog. book 3. chap. 10.
(*o*) Santorin. Obſervat. anatomic. cap. 5. § 9.
(*p*) Id. ibid. cap. 5. § 7.
(*q*) Hunauld Memoires de l'acad. des ſciences, 1730.
(*r*) Columb. de re anat. lib. 1. cap. 8.—Fallop. Obſervat. anatom

The figure of this bone is an irregular rhomboid.—Its ſides are flat and ſmooth.—Its poſterior edge appears in an oblique direction at the back-part of the noſtrils.—The upper one is firmly united to the baſe of the *ſphenoid* bone, and to the naſal plate of the *ethmoid;* and, when it can be got ſeparated, is hollow, for receiving the *proceſſus azygos* of the *ſphenoid.*—The anterior edge has a long furrow in it, where the middle cartilage of the noſe enters.—The lower edge is firmly united to the naſal ſpines of the maxillary and palate bones.—Theſe edges of this bone are much thicker than its middle, which is as thin as the fineſt paper; by which, and the firm union or connection this bone has above and below, it can very ſeldom be ſeparated entire in adults: But, in a child, it is much more eaſily ſeparated entire, and its ſtructure is more diſtinctly ſeen: Wherefore I ſhall examine all its parts of ſuch a ſubject.

Its ſituation is not always perpendicular, but often inclined and bended to one ſide, as well as the naſal plate of the *ethmoid* bone.

The *vomer* is convex at its upper part, and then is ſtraight, as it is extended downwards and forwards, where it is compoſed of two plates; the edges of which have a great number of ſmall proceſſes, diſpoſed ſomewhat like the teeth of a ſaw, but more irregularly, and ſeveral of them are reflected back. Between theſe plates a deep *foſſa* is left, which, ſo far as the top of the curvature, is wide, and has ſtrong ſides, for receiving the *proceſſus azygos* of the *ſphenoid* bone. Beyond the arch forwards, the *foſſa* is narrower and ſhallower gradually to the point of the bone, receiving for ſome way the naſal *lamella ethmoidea;* which, after the oſſification is complete, is ſo cloſely united to the *vomer* by the little proceſſes piercing into its ſubſtance, as to prevent any ſeparation; on which account, it has been eſteemed by ſome (*s*) a part of the ethmoid bone. The middle cartilage of the noſe fills up what remains of the *foſſa*

(*s*) Lieutaud. Eſſais anatomiques 1. ſect. l'os ethmoide.

fossa at its fore-part.—The posterior edge of the *vomer*, which appears above the back-part of the palate bones, is broader above; but as it descends forwards, becomes thinner, though it is still solid and firm.—The lower edge of this bone, which rests on the nasal spine of the *palate* and *maxillary* bones, has a little furrow on each side of a small middle ridge, answering to the spines of the bones of different sides, and the interstices between them. This edge, and the upper one, meet in the pointed fore-end of this bone.

The body of the *vomer* has a smooth surface, and solid, but thin substance; and towards its sides, where it is thickest, some *cancelli* may be observed, when the bone is broken.

It is joined above to the *sphenoid* and *ethmoid* bones, and to the middle cartilage of the nose by *schyndelesis*;—below, to the maxillary and palate bones, by the *spinous* suture.

The *vomer* divides the nostrils, enlarges the organ of smelling, by allowing place for expanding the membrane of the nose on its sides, and sustains the palate-plates of the *maxillary* and *palate* bones, which otherwise might be in hazard of being pressed into the nostrils; while the *vomer* is secured from shuffling to one side or other by the double *schyndelesis*, by which it is joined to the bones above and below.

These, then, are all the bones which compose the upper jaw, except the teeth, which are so much akin to those of the lower jaw, that I choose to make one description serve for both, in which the differences observable in them shall be remarked, after the second part of the face, the lower jaw, is examined; because the structure of the teeth cannot be well understood, until the case in which they are set is explained.

MAXILLA INFERIOR (*t*), the lower jaw, consists

(*t*) Γενυς, σιαγων, mandibula, facies.

fiſts only of one moveable bone, and ſixteen teeth incaſed into it.

This bone, which is ſomewhat of the figure of the *Greek* letter υ, is ſituated at the lower part of the face, ſo as its convex middle part is forwards, and its legs are ſtretched back. It is commonly divided into the chin, ſides, and proceſſes.—The *chin* is the middle fore-part, the extent of which to each ſide is marked on the external ſurface by the holes obſervable there, and internally by the beginning of an oblique ridge.—Beyond theſe the *ſides* appear, and are continued till the bone, by bending upwards, begins to form the proceſſes.

On the fore-part of the *chin*, a tranſverſe ridge appears in the middle, on each ſide of which the *muſculi quadrati*, or *depreſſores labii inferioris*, and the *levatores labii inferioris*, depreſs the bone: And below theſe prints, a ſmall riſing may be obſerved, where the *depreſſores* commence.—On the back-part of the chin, ſometimes three, always two, ſmall protuberances appear in the middle. To the uppermoſt, when it is ſeen, the *frænum* of the tongue is connected. From the middle one, the *muſculi genio-gloſſi* riſe; and from the loweſt, the *genio-hyoidei* have their origin. Below the laſt, we ſee two rough ſinuoſities formed by the *digaſtric* muſcles.

At the lower and fore-part of the external ſurface of each ſide of the lower jaw, a ſmall eminence may be obſerved, where the *depreſſor labiorum communis* riſes. Near the upper edge of the ſide, a ridge runs length-ways, to which the under-part of the *muſculus buccinator* is connected.—Internally, towards the upper edge of each ſide, another ridge appears, from which the *mylo-hyoidei* have their origin, and to which the internal membrane of the gums adheres.

In the upper edge of both chin and ſides are a great many deep pits or ſockets, for receiving the roots of the teeth. The number and magnitude of theſe ſockets are various, becauſe of the different number, as well of the teeth themſelves, as of their

K roots,

roots, in different people. These sockets in this lower jaw, as well as in the upper one, are less deep as old age comes on; when freed from the teeth by any means, they are some time after filled up with an osseous net-work, which at last becomes entirely solid, and as smooth as any other part of the bone so that in a great many old jaws, one cannot observe a vestige of the sockets: But then the jaw becomes less, and much narrower (*u*).—Hence we may know why the chin and nose of edentulous people are much nearer than before the teeth were lost; while their lips either fall in towards the mouth, or stand prominent forwards.—When new teeth are protruded, new sockets are formed (*x*).—The lower edge of the chin and sides is smooth and equal, and is commonly called the *base* of the lower jaw.—The ends of the base where the jaw turns upwards, are called its *angles* the external surface of each of which has several inequalities upon it, where the *masseter* muscle is inserted; as the internal surface also has, where the *pterygoideus internus* is inserted, and a ligament extended from the *styloid* process of the temporal bone is fixed.

The processes are two on each side.—The anterior sharp thin *coronoid* ones have the *crotaphyte* muscle inserted into them.—The posterior processes or *condyles* (*y*) terminate in an oblong smooth head, supported by a *cervix*. The heads, whose greatest length is transverse, and whose convexity is turned forwards are tipped with a cartilage, as the articulated part of all other moved bones are.—The fore-part of the root and neck of these *condyloid* processes are a little hollow and rough, where the external *pterygoid* muscles are inserted.

The holes of the lower jaw are two on each side one at the root of the processes internally, where large branch of the third branch of the fifth pair of nerve

(*u*) Vesal. Anat. lib. 1. cap. 10.
(*x*) Fallop. Observ. anat.
(*y*) Articulatorii.

nerves enters with an artery, and a vein returns. A small sharp process frequently juts out backwards from the edge at the fore-part of this hole, to which a ligament extended from the temporal bone is fixed (y), which saves the nerve and vessels from being too much pressed by the *pterygoid* muscles.—From the lower side of this hole, either a small superficial canal or a furrow descends, where a branch of the nerve is lodged, in its way to the *mylo-hyoideus* muscle and sublingual gland (z). The other hole is external, at the confines of the chin, where branches of the nerve and vessels come out.—The canal betwixt these two holes is formed in the middle of the substance of the bone, and is pierced by a great number of small holes, by which the nerves and blood-vessels of the *cancelli* and teeth pass.—This canal is continued a little further than the external hole at the chin.—On account of the vessels and nerves in the lower jaw, fractures of it may be attended with dangerous symptoms.

The surface of the lower jaw is hard and firm, except at the spongy sockets, where however it is stronger than the upper jaw.—Its internal substance is cellular, without any solid partition between the *cancelli* in its middle.—At the base, especially of the chin, where this bone is most exposed to injuries, the solid sides of it are thick, compact, and hard.

The lower jaw generally receives the roots of sixteen teeth into its sockets, by *gomphosis*; and its *condyloid* processes, covered with cartilage, are articulated with the *temporal* bones, in a manner that is not commonly described right: For, as was already mentioned in the description of the temporal bones, not only the fore-part of the cavity between the *zygomatic*, *auditory*, and *vaginal* processes, but also the adjoining tubercle at the root of the *zygomatic* process of each *os temporum* is covered with a smooth cartilage, for this articulation. Here also an intermediate moveable cartilage is placed,

(y) Weitbrecht Syndesmolog. fig. 32. I.
(z) Palfyn. Anat. chirur. traité 5. chap. 6.

ced, which being thin in the middle, and thick at the edges, is concave on both ſides; and is connected ſo firmly by ligaments to each *condyle*, as to follow the motions of the *condyle*; and ſo looſely to the *temporal* bone, as readily to change its ſituation from the cavity to the tubercle, and to return again; while the common ligament of the articulation affords ſpace enough for ſuch a change of place backwards and forwards; but, like other ligaments of the joints by *ginglimus*, is ſtrong and ſhort at the ſides, to confine the lateral motions.

When therefore the teeth of both jaws coincide, the *condyles* are lodged ſecurely in the temporal cavities, but their motions to either ſide muſt be confined both by the firmneſs of the ligaments, and the riſing brims which are on each ſide of the cavities.—When the jaw is brought directly forwards, the condyle and intermediate cartilages deſcend and advance forwards upon the tubercles.—In this ſituation the lateral motions are a little more free than in the former one, from the want of riſing brims to ſtop the condyles.—When the fore-teeth of the lower jaw are moved forwards, and to a ſide, the condyle of the oppoſite ſide is either advanced from the cavity to the tubercle, while the condyle of the ſame ſide remains in the cavity; or if both condyles are on the tubercles, when the jaw is moved obliquely to a ſide, the condyle of the ſide to which the motion is made, ſlides back from the tubercle to the cavity.—When the mouth is opened by the deſcent of the lower jaw, the fore-part of it, where the *depreſſing* muſcles are fixed, is drawn backwards, as well as downwards, while reſiſtance is made to the angles moving backwards by the *maſſeter* and *internal pterygoid* muſcles, and, at the ſame time, the *external pterygoid* draw the condyles and their moveable cartilages forwards; and therefore, when the mouth is opened, the condyles are carried forwards upon the tubercles, and the axis of motion of the bone is a little above its angles. But in this ſituation there is leſs reſiſtance than in any

any other, to the condyles luxating forwards; a disease which seldom happens, except when people are gaping too wide; and therefore the common practice of nurses, who support the jaw of infants when they are yawning, is reasonable.—In chewing there is a succession of the motions above described (*a*).

Here a general remark may be made, That wherever moveable cartilages are found in joints, either the articulated bones are of such a figure, or so joined and fixed by their ligaments, that little motion would be allowed without such cartilages; or else some motions are necessary to the right use of the member, which the form of the articulation would not otherwise admit of. This will more fully appear after the other joints with such cartilages are described.

In a child born to the full time, the lower jaw is composed of two bones, connected by a thin cartilage in the middle of the chin, which gradually ossifies, and the two bones intimately unite.—In each of these bones there are five or six sockets for teeth, as in the upper jaw.

After I have thus described the incasement of the teeth, the insertion of so many muscles of the tongue, and of the *os hyoides*, the connection of the membrane of the tongue to the maxillary bone, and the motions of this bone; it is easy to see, that the lower jaw must be a principal instrument in manducation, deglutition, and speech.

The *TEETH* are the hard white bodies placed in the sockets of both jaws. Their number is generally sixteen above, and as many below; though some people have more, others have fewer.

The broad thick part of each tooth which appears without the socket, is the *base* or body (*b*).—The smaller processes sunk into the *maxillæ*, are the *roots* or

(*a*) For a more full account of this articulation, *vide* Edinburgh Medical Essays and observ. vol. I. art. II. and vol. 3. art. 13.—Memoires de l'acad. des sciences, 1744.

(*b*) Corona.

or *fangs*, which become gradually ſmaller towards the end fartheſt from the baſe, or are nearly conical, by which the ſurface of their ſides divides the preſſure made on the baſes, to prevent the ſoft parts, which are at the ſmall points of the ſockets, to be hurt by ſuch preſſure.—At the place where the baſe ends, and the roots begin, there is generally a ſmall circular depreſſion, which ſome call the *neck* or *collar*.

Without the gums, the teeth are covered with no membrane, and they are ſaid to have no proper *perioſteum* within the ſockets; but that is ſupplied by the reflected membrane of the gums; which, after a good injection, may be evidently ſeen in a young ſubject, with the veſſels from it penetrating into the ſubſtance of the teeth; and it may be diſcovered in any tooth recently pulled, by macerating it in water (*c*). The adheſion of this membrane to theſe roots is ſtrengthened by the ſmall furrows obſervable on them.

Each tooth is compoſed of its *cortex*, or *enamel*, and an internal bony ſubſtance. The *cortex* has no cavity or place for marrow; and is ſo ſolid and hard, that ſaws or files can with difficulty make impreſſion on it. It is thickeſt upon the baſe, and gradually, as the roots turn ſmaller, becomes thinner, but not proportionally to the difference of the ſize of the baſe and roots.—The fibres of this enamel are all perpendicular to the internal ſubſtance, and are ſtraight on the baſe, but at the ſides are arched with a convex part towards the roots (*d*); which makes the teeth reſiſt the compreſſion of any hard body between the jaws, with leſs danger of breaking theſe fibres, than if they had been ſituated tranſverſely. The ſpongy ſockets in which the teeth are placed, likewiſe ſerve better to prevent ſuch an injury, than a more ſolid baſe would have done.—Notwithſtanding the great hardneſs of this *cortex*, it is waſted by manducation. Hence

(*c*) Cowper Anatom. explicat. tab. 92. fig. 7. lit. E.
(*d*) Haver's Oſteolog. nov. diſc. 1.

Hence the ſharp edges of ſome teeth are blunted, and made broad, while the rough ſurfaces of others are made ſmooth and flat, as people advance in life.

The bony part of the teeth has its fibres running ſtraight, according to the length of the teeth. When it is expoſed to the air, by the breaking or falling off of the hard *cortex*, it ſoon corrupts. And thence carious teeth are often all hollow within, when a very ſmall hole appears only externally.

The teeth have canals formed in their middle, wherein their nerves and blood-veſſels are lodged; which they certainly need, being conſtantly waſted by the attrition they are ſubjected to in manducation, and for their further growth, not only after they firſt appear, but even in adults; as is evident when a tooth is taken out: For then the oppoſite one becomes longer, and thoſe on each ſide of the empty ſocket turn broader; ſo that when the jaws are brought together, it is ſcarce obſervable where the tooth is wanting (*a*).

The veſſels are eaſily traced ſo long as they are in the large canal, but can ſcarce be obſerved in their diſtribution from that to the ſubſtance of the teeth of adults. Ruyſch (*b*) however affirms, that after injection, he could trace the arteries into the hardeſt part of the teeth: And Leewenhoek (*c*) ſuſpected the fibres of the *cortex* to be veſſels. In children I have frequently injected the veſſels of the teeth as far as their baſe: And in ſuch as are not intirely oſſified, one can with a lucky injection fill ſo many veſſels, as to make both the outſide and inſide of the cortical part appear perfectly red.—This plentiful ſupply of veſſels muſt expoſe the teeth to the ſame diſorders that attack other vaſcular parts; and ſuch teeth as have the greateſt number of veſſels, muſt have the moſt numerous chances of being ſeized with theſe diſeaſes.

Every root of each tooth has ſuch a diſtinct canal, with

(*a*) Ingraf. de tumor. cap. 1. p. 24. 25. 26.
(*b*) Theſaur. 10. num. 27.
(*c*) Arcan. natur. continuat. epiſt. p. 3.

with veſſels and nerves in it. Theſe canals in the teeth with more than one root, come nearer each other, as they approach the baſe of the tooth; and at laſt are only ſeparated by very thin plates, which being generally incompleat, allow a communication of all the canals; and frequently one common cavity only appears within the baſe, in which a pulpy ſubſtance compoſed of nerves and veſſels is lodged. The condition therefore of the nerves here, bears a ſtrong analogy to that of the cutaneous nerves which ſerve for the ſenſation of touching.

The entry of the canals for theſe veſſels is a ſmall hole placed a little to a ſide of the extreme point of each root; ſometimes, eſpecially in old people, this hole is entirely cloſed up, and conſequently the nerves and blood-veſſels are deſtroyed (*d*).

The teeth are ſeen for a conſiderable time in form of *mucus* contained in a membrane, afterwards a thin cortical plate, and ſome few oſſeous layers appear within the membrane, with a large cavity filled with *mucus* in the middle; and gradually this exterior ſhell turns thicker, the cavity decreaſes, the quantity of *mucus* is leſſened, and this induration proceeds till all the body is formed; from which the roots are afterwards produced.

In young ſubjects, different *ſtamina* or rudiments of teeth are to be obſerved. Thoſe next the gums hinder ordinarily the deeper ſeated ones from making their way out, while theſe prevent the former from ſending out roots, or from entering deep into the bony ſockets of the jaws; by which they come to be leſs fixed.

Children are ſeldom born with teeth; but at two years of age they have twenty; and their number does not increaſe till they are about ſeven years old, when the teeth that firſt made their way through the gums are thruſt out by others that have been formed deeper in the jaw, and ſome more of the teeth begin to diſcover themſelves farther back in the mouth. About

(*d*) De la Hire Hiſtoire de l'acad. des ſciences, 1699.

About fourteen years of age, ſome more of the firſt crop are ſhed, and the number is increaſed.—This ſhedding of the teeth is of good uſe; for if the firſt had remained, they would have ſtood at a great diſtance one from another; becauſe the teeth are too hard in their outer cruſt, to increaſe ſo faſt as the jaws do. Whereas both the ſecond layer, and the teeth that come out late, meeting, while they are ſoft, with a conſiderable reſiſtance to their growth in length, from thoſe ſituated upon them, neceſſarily come out broad, and fit to make that cloſe guard to the mouth (*e*), which they now form.

The teeth are joined to the ſockets by *gomphoſis*, and the gums contribute to fix them there; as is evident by the teeth falling out when the gums are any way deſtroyed, or made too ſpongy; as in the *ſcurvy* or *ſalivations:* whence ſome (*g*) claſs this articulation with the *ſyſſarcoſis*.

The uſes of the teeth are to maſticate our aliment, and to aſſiſt us in the pronunciation of ſeveral letters.

Though the teeth ſo far agree in their ſtructure, yet, becauſe of ſome things wherein they differ, they are generally divided into three claſſes, *viz. inciſores, canini*, and *molares*.

The *inciſores* (*h*) are the four fore-teeth in each jaw, receiving their name from their office of cutting our aliment; for which they are excellently adapted, being each formed into a ſharp cutting edge at their *baſe*, by their fore-ſide turning inwards there, while they are ſloped down and hollowed behind (*i*); ſo that they have the form of wedges; and therefore, their power of acting muſt be conſiderably increaſed.—Seeing in the action of the *inciſores*, a perpendicular compreſſion is only neceſſary, without any lateral motion, they are not ſo firmly fixed in their ſockets as

(*e*) Φραγμος.

(*g*) Drake's Anthropolog. book 4. chap. 3.

(*h*) Γελασινοι, τομικοι, διχαςηρες, κτενες, τομεις, πρωσθιοι, οξεις, [...]orii, quaterii, primi, primores, anteriores, acuti.

(*i*) Ολμισκος.

as the other teeth are, each having only one ſhort root, but that is broader from before backwards, than to either ſide, to have the greateſt ſtrength where it is expoſed to the ſtrongeſt force applied to it (*k*).

The *inciſores* of the upper jaw, eſpecially the two middle ones (*l*), are broader and longer generally than thoſe of the under jaw.

In a new-born infant, the outer ſhell of the body of theſe teeth is only hardened.—Afterwards, when the *ſtamina* of two ſets are formed, each has its own ſocket, thoſe neareſt to the edge of the gums being placed more forward, and the others are lodged farther back within the jaw-bones.

Canini (*m*), from the reſemblance to dogs tuſks, are one on each ſide of the *inciſores* in each jaw.—The two in the upper jaw are called *eye-teeth*, from the communication of nerves which is ſaid to be betwixt them and the eyes.—The two in the lower jaw are named *angular* or *wike-teeth*, becauſe they ſupport the angles of the mouth.

The *canini* are broader, longer, and ſtronger, than the *inciſores*.—Their baſes are formed into a ſharp edge, as the *inciſores* are; only that the edge riſes into a point in the middle.—Each of them has generally but one long root, though ſometimes they have two (*n*). The roots are crooked towards the end.—The *canini* of the upper jaw are larger, longer, and with more crooked roots, than thoſe of the under jaw.—The form of their baſe is fit both for piercing and cutting, and the long crooked root of each makes it ſecure in the ſocket.

The *canini* of a child are in much the ſame condition as the *inciſores* are.

The *dentes molares*, or *grinders* (*o*), which have got their name becauſe they grind our food, are generally

(*k*) Lettre ſur l'oſteologie, aſcribed to Du Verney.

(*l*) Duales.

(*m*) Κυνοδοντες, riſorii, fractorii, collaterales, collumellares.

(*n*) Fauchard, Chirurgien dentiſte, chap. 1.

(*o*) Μυλιται, γομφοι, μυλοι, πλατεις, φραστηρες, maxillares, menſales, clavales, buccarum.

ly five in each ſide of each jaw; in all twenty. Their baſes are broader, more ſcabrous, and with a thinner cortical ſubſtance, than the other teeth. They have alſo more roots, and as theſe roots generally divaricate from each other, the partitions of the ſockets between them bear a large ſhare of the great preſſure they ſuffer, and hinder it to act on their points (*p*).

The baſe of the firſt grinder has an edge pointed in the middle, on its outſide, reſembling the *canini*; from which it ſlopes inwards till it riſes again into a point.—It has generally but one root, which ſometimes is long and crooked at its point.

The ſecond *dens molaris* has two points on its baſe, riſing near equally on its out and inſide.—It has two roots, either ſeparate or run together, but ſhorter than the root of the firſt.—Theſe two anterior grinders are much ſmaller than the three that are placed farther back in the mouth.

The third and fourth are very broad in their baſes, with four or five points ſtanding out; and they have three or more roots.

The fifth, called commonly *dens ſapientiæ* (*q*), from its coming through the gums later than the other grinders, has four points on its baſe, which is not ſo large as the baſe of the third and fourth, and its roots are leſs numerous.

The *inciſores* of the upper jaw, being broader than thoſe of the lower jaw, make the ſuperior grinders to be placed ſo much farther back than the lower ones, that when they are brought together, by ſhutting the mouth, the points of the grinders of the one jaw enter into the depreſſions of the oppoſite grinders, and they are all equally applied to each other, notwithſtanding the inequality of their ſurface.

The numerous roots of the *dentes molares* prevent their looſening by the lateral preſſure they ſuffer in grinding; and as the ſockets in the upper jaw are more

(*p*) Lettre ſur l'oſteologie.

(*q*) Σωφρονιςηρες, κραντηρες, ὀψιγονοι, ſenſus, intellectus, ſerotini, ætatem complentes, genuini, moderatores.

more ſpongy, and the teeth are more liable, by their ſituation, to fall out (*r*), the grinders there have more numerous and more ſeparated roots than in the lower jaw (*s*). The number however of the roots of the teeth of both jaws is very uncertain; ſometimes they are more, ſometimes fewer; frequently ſeveral roots are joined together; at other times they are all diſtinct. The diſpoſition of ſuch as are diſtinct is alſo various; for in ſome the roots ſtand out ſtraight, in others they ſeparate, and in others again they are crooked inwards. When the roots are united, we can ſtill diſtinguiſh them, by remarking the number of ſmall holes at their points, which determine the number of roots each tooth ought to be reckoned to have.

At the time of birth only two *dentes molares* in each jaw have begun to oſſify, and that at little more than the baſe; which has ſeveral ſharp points ſtanding out from it.—The temporaneous grinders are placed more directly upon the internal ſet than the other two claſſes are; ſometimes there is a piece of the bone of the jaws between the two ſets; in other children, the two ſets have no bone interpoſed between them.

From what has been ſaid, the anſwers to the following queries may be given.

Why are children ſubject to ſalivation, fever, convulſion, vomiting, purging, &c. when their teeth are breeding or cutting the gums?

Why in children do the *dentes inciſores* firſt cut the gums, the *canini* next, and *molares* laſt?

Why do children ſhed their teeth?

Wherefore have theſe *temporaneous* teeth generally no roots, or very ſmall ones?

Why have theſe firſt teeth ſometimes roots, and that more frequently in teeth pulled by art than in thoſe which are ſhedded by nature (*a*)?

Why

(*r*) Galen. de oſſib. cap. 5.
(*s*) Fauchard. Chirurg. dent. chap. 1.
(*a*) Fauchard. Chirurgien dentiſte, p. 7.

Why do theſe roots frequently come outwards hrough the gums?

Whence come *butter* or *buck* teeth?

How do theſe teeth ſometimes go into the natural ow with the others, after pulling a rotten tooth near hem?

How have ſome people got two rows of teeth in ne or both jaws (*b*)?

Why do the teeth of old people looſen, and then lrop out entire?

Whence ariſe the new ſets of teeth which ſeveral ld people obtain (*c*)?

Why are not the gums of toothleſs old people torn y the hard ſockets in chewing?

Why are the teeth inſenſible when ſlightly filed or aſped?

How come they to be ſenſible of heat or cold, to e ſet on edge by acids, or to give an uneaſy ſenſa-en when gritty or ſandy ſubſtances are rubbed be-ween them?

Why does a perſon who has a pained tooth imagine longer than any other?

What is the reaſon of ſome perſons dying convul-d, upon raſping or filing down an overgrown tooth (*d*)?

How do the teeth break and moulder away with-ut any pain in ſome people, and not in others?

What parts are affected in the tooth-ach?

What are the cauſes of the tooth-ach?

May worms be reckoned among theſe cauſes (*e*)?

Why are the *dentes molares* moſt ſubject to that ſeaſe?

In what different manners ought the ſeveral claſſes teeth to be extracted when ſuch an operation is eceſſary?

Whence proceeds the violent obſtinate *hemorrhagy*

L which

(*b*) Blaſ. comment. ad Veſling. Syntagm. cap. 1. 3.

(*c*) Hoffman. in Van Horn. microcoſm. p. 38.

(*d*) Bartholin. Anat. reformat. lib. 4. cap. 12.

(*e*) Jacob. in Act. Hafn. vol. 5. obſ. 107.—Pechlin. Obſerv. me-. lib. 2. obſ. 36.—Bartholin. Hiſt. medic. cent. 3. hiſt. 96.

which ſometimes attends the drawing of teeth (*c*)?

Why is it more difficult and dangerous to draw the eye-teeth than any other?

What makes it impoſſible frequently to draw *grinders* without bringing away part of the jaw-bone with them, or breaking the fangs?

Why do teeth ſoon replaced after being extracted, become again fixed in the ſockets (*d*)?

According to the diviſion made of the ſkeleton, we ſhould now proceed to the deſcription of the trunk of the body. But muſt firſt conſider a bone, which cannot well be ſaid to belong to either the head or the trunk; nor is it immediately joined to any other, and therefore is very ſeldom preſerved with ſkeletons. However, it is generally deſcribed by authors after the bones of the face: In obedience therefore to the prevailing method, I ſhall next examine the ſtructure of

The *OS HYOIDES* (*e*), which is ſituated horizontally between the root of the tongue and the *larynx*. It is properly enough named *hyoides*, from the reſemblance it bears to the *Greek* letter υ, and may, for a clearer demonſtration of its ſtructure, be diſtinguiſhed into its *body*, *cornua*, and *appendices*.

The body is the middle broad part, convex before, and hollow behind.—The convex fore-part is divided into two, by a ridge, into the middle of which the *mylo-hyoidei*, and into the ſides the *ſtylo-hyoidei*, muſcles are inſerted.—Above the ridge, the bone is horizontal, but pitted in the middle by the inſertion of the two *genio-hyoidei* muſcles, and a little hollowed more laterally by the *baſio-gloſſi*.—Below the ridge, it is convex, but a little flatted in the middle by the *ſterno-hyoidei*, and pitted more externally by the *coraco-hyoidei*.—

(*c*) Pare, livre 6. chap. 2.—Rolfinc. lib. 2. cap. 27. et 30.—Moebii Fundam. medicin. cap. 9.—Ephemerid. German. dec. 1. ann. 3 obſ. 319.—Fauch. Chirurg. dentiſte, tom. 1. chap. 23. obſerv. 7.

(*d*) De la Motte Chirurgie, tom. 1. chap. 4. obſ. 2.—Fauchard Chirurgien dentiſte, tom. 1. chap. 29.

(*e*) Hypſyloides, Lambdoides, παραςατη, φαρυγγετερον, os gutturis os linguæ, os morſus Adami, aſſeſſor, os laude, bicorne.

hyoidei.—The concavity behind faces backwards and downwards to receive the *thyroid* cartilage, when the *larynx* and the *os hyoides* are pulled towards each other by the action of the *sterno-hyoidei* and *hyo-thyroidei* mufcles; and to its upper edge, the ligamentous membranes of the *epiglottis*, tongue, and *thyroid* cartilage, are fixed.

The *cornua* of the (*i*) *os hyoides* are ftretched backwards from each fide of its body, where often a fmall furrow points out the former feparation; for in young fubjects, the body and *cornua* are not one continued fubftance, as they come afterwards to be in adults.—Thefe *cornua* are not always ftraight, nor of equal length; their two plain furfaces ftand obliquely floping from above outwards and downwards.—Into the external, the *cerato-gloffus* is inferted above, and the *thyro-hyoideus* mufcle below; and to the one behind, the ligamentous membrane of the tongue and *larynx* adheres. Each of the *cornua* becomes gradually fmaller, as it is extended from the bafe; but ends in a round tubercle, from which a moveable cartilage ftands out, which is connected to the upper procefs of the *cartilago-thyroidea*.

Where the body of the *os hyoides* joins on each fide with its *cornua*, a fmall ftyliform procefs, called *appendix* (*g*), rifes upwards and backwards, into which the *mufculi ftylo-hyoidei alteri*, and part of the *hyo-gloffi* mufcles are fixed. From each of them a ligament is fometimes extended to the *ftyloid* proceffes of the temporal bones, to keep the *os hyoides* from being drawn too much forwards or downwards. The part of this ligament next to thefe proceffes fometimes forms into feveral cartilages, which afterwards offify in old people. *Ruyfch* (*h*) fays, that he has feen this offification continued as far up as the ftyloid proceffes, which were therefore joined to the *os hyoides* by *anchylofis*.

The fubftance of the *os hyoides* is cellular, but covered with a firm external plate, which is of fufficient

L 2 ftrength

(*i*) Crura, latera inferiora.

(*g*) Crura fuperiora, latera fuperiora, offa graniformia.

(*h*) Adverf. anat. dec. 3. § 9.

ſtrength to bear the actions of ſo many muſcles as are inſerted into it.

It is not articulated with any bone of the body, except by means of the muſcles and ligaments mentioned.

The uſe of the *os hyoides*, is to ſerve as a ſolid lever for the muſcles to act with, in raiſing or depreſſing the tongue and *larynx*, or in enlarging and diminiſhing the capacity of the *fauces*.

At birth, this bone is in a cartilaginous ſtate; excepting a ſmall point of bone in the middle of its body, and in each of the *cornua*.—The *appendices* frequently remain cartilaginous many years.

OF THE TRUNK.

THE *TRUNK* conſiſts of the *ſpine*, *pelvis*, and *thorax*.

The *SPINE* (*a*) is the long pile of bones extended from the *condyles* of the *occiput* to the end of the rump. It ſomewhat reſembles two unequal pyramids joined in a common baſe. It is not, however, ſtraight; for its upper part being drawn backwards by ſtrong muſcles, it gradually advances forwards, to ſupport the *œſophagus*, veſſels of the head, &c. Then it turns backwards, to make place enough for the heart and lungs. It is next bended forwards, to ſupport the *viſcera* of the *abdomen*. It afterwards turns backwards, for the enlargement of the *pelvis*. And laſtly, it is reflected forwards, for ſuſtaining the loweſt great gut.

The *ſpine* is commonly divided into *true* and *falſe vertebræ*; the former conſtituting the long upper pyramid, which has its baſe below; while the *falſe vertebræ* make the ſhorter lower pyramid, whoſe baſe is above.

The

(*a*) Ραχις νωτον ακανθα, ιερα συριγξ, σωλην, tergum, hominis carina.

The *TRUE VERTEBRÆ* (*b*) are the twenty four upper bones of the *spine*, on which the several motions of the trunk of our bodies are performed; from which use they have justly got their name.

Each of these *vertebræ* is composed of its body and processes.

The body is the thick spongy fore-part, which is convex before, concave backwards, horizontal and plain in most of them above and below.—Numerous small holes, especially on the fore and back part of their surface, give passage to their vessels, and allow the ligaments to enter their substance.—The edges of the body of each *vertebra* are covered, especially at the fore-part, with a ring of bone firmer and more solid than the substance of the body any where else. These rings seem to be joined to the *vertebræ* in the form of *epiphyses*, but are alledged by some (*c*) to be the ligaments ossified. They are of great use in preventing the spongy bodies from being broken in the motions of the trunk.

Between the bodies of each two adjoining *vertebræ*, a substance between the nature of ligament and cartilage is interposed; which seems to consist of concentrical curve fibres, when it is cut horizontally; but when it is divided perpendicularly, the fibres appear oblique and decussating each other (*d*).—The outer part of the intervertebral ligaments is the most solid and hard; and they gradually become softer till they are almost in the form of a glairy liquor in the centre; and therefore these substances were not improperly called *mucous ligaments* by the ancients (*e*). The external fibrous part of each is capable of being greatly extended, and of being compressed into a very small space, while the middle fluid part is incompressible, or nearly so; and the parts of this ligament

 between

(*b*) Στροφεις, στροφιγγες, spondyli, ossa orbiculata, ossa vertebrata, verticula.

(*c*) Fallop. Observat. anatom.

(*d*) Blancard, Anat. reform. cap. 32.—Weitbrecht, Syndesmolog. sect. 4. § 15.

(*e*) Galen de usu part. lib. 12. cap. 16.

between the circumference and centre approach in their properties to either, in proportion to their more ſolid or more fluid texture. The middle point is therefore a *fulcrum*, or *pivot*, on which the motion of a ball and ſocket may be made, with ſuch a gradual yielding of the ſubſtance of the ligament, in whichever direction our ſpines are moved, as ſaves the body from violent ſhocks, and their dangerous conſequences *(f)*.—This ligamento-cartilaginous ſubſtance is firmly fixed to the horizontal ſurfaces of the bodies of the *vertebræ*, to connect them, in which it is aſſiſted by a ſtrong membranous ligament, which lines all their concave ſurface, and by ſtill a ſtronger ligament that covers all their anterior convex ſurface.

We may lay it down as a general rule, notwithſtanding ſome exceptions, That the *bodies* of the *vertebræ* are ſmaller, and more ſolid above; but as they deſcend, they appear larger and more ſpongy; and that the cartilages between them are thick, and the ſurrounding ligaments ſtrong, in proportion to the largeneſs of the *vertebræ*, and to the quantity of motion they perform: By which diſpoſition, the greater weight is ſupported on the broadeſt beſt ſecured baſe, and the middle of our body is allowed a large and ſecure motion.

From each ſide of the body of each *vertebra*, a bony bridge is produced backwards, and to a ſide; from the poſterior end of which, one ſlanting proceſs riſes, and another deſcends; the ſmooth, and what is generally the flatteſt ſide of each of theſe four proceſſes, which are called the *oblique* (*g*), is covered with a ſmooth cartilage; and the two lower ones of each *vertebra* are fitted to, and articulated with, the two upper or aſcending oblique proceſſes of the *vertebra* below, having their articular ligaments fixed into the rough line round their edges.

From

(*f*) Medical eſſays and obſerv. vol. 5. art. 28.
(*g*) Articulatorii, minimi.

From between the oblique proceſſes of each ſide, the *vertebra* is ſtretched out laterally into a proceſs that is named *tranſverſe*.

From the back-part of the roots of the two oblique, and of the tranſverſe proceſs of each ſide, a broad oblique bony plate is extended backwards; where theſe meet, the ſeventh proceſs of the *vertebræ* takes its riſe, and ſtands out backwards: This being generally ſharp pointed and narrow edged, has therefore been called *ſpinal* proceſs; from which this whole chain of bones has got its name.

Beſides the common ligament which lines all the internal ſurface of the ſpinal proceſſes, as well as of the bodies, there are particular ligaments that connect the bony bridges and proceſſes of the contiguous *vertebræ* together.

The ſubſtance of the proceſſes is conſiderably ſtronger and firmer, and has a thicker external plate than the bodies of the *vertebræ* have.

The ſeven proceſſes form a concavity at their fore-part, which, joined to the one at the back-part of the bodies, makes a great hole; and the holes of all the *vertebræ* form a long large conduit (*h*), for containing the *ſpinal marrow*.—In the upper and lower edge of each *lateral bridge*, there is a notch. Theſe are ſo adapted to each other in the contiguous *vertebræ*, as to form a round hole in each ſide between each two *vertebræ*, through which the nerves that proceed from the *ſpinal* marrow and its blood-veſſels paſs.

The articulations then of theſe *true vertebræ* are plainly double; for their bodies are joined, by the intervening cartilage above deſcribed; and their oblique proceſſes being tipped with cartilages, are ſo connected by their ligaments, as to allow a ſmall degree of motion to all ſides. Hence it is evident, that their centre of motion is altered in different poſitions of the trunk: For when we bow forwards, the upper moved part bears entirely on the bodies of the *vertebræ*: If we bend back, the oblique proceſſes ſupport

(*h*) Ιερα συριγξ, σωλην, Canalis.

port the weight: If we recline to one ſide, we reſt upon the oblique proceſſes of that ſide and part of the bodies: If we ſtand erect, all the bodies and oblique proceſſes have their ſhare in our ſupport.

Hence it follows, 1. That becauſe the joints of which the ſpine is compoſed are ſo numerous, the *ſpinal* marrow, nerves, blood-veſſels, &c. are not liable to ſuch compreſſion and over-ſtretching in the motion of the trunk of the body, as they would otherwiſe be, ſince ſeveral *vertebræ* muſt be concerned in every motion of the ſpine; and therefore a very ſmall curvature is made at the conjunction of any two *vertebræ* (*i*). 2. That an erect poſture is the ſureſt and firmeſt, becauſe the ſurface of contact of the *fulcra* is largeſt, and the weight is moſt perpendicular to them (*k*). 3. That the muſcles which move the ſpine, act with greater force in bringing the trunk to an erect poſture, than in drawing it to any other: for in bending forwards, backwards, or to a ſide, the muſcles which perform any of theſe actions are nearer the centre of motion; conſequently the lever with which they act is ſhorter, than when the centre of motion is on the part of the *vertebra*, oppoſite to that where theſe muſcles are inſerted; which is the caſe in raiſing the trunk. This is extremely neceſſary; ſince, in the deflections of the ſpine from a perpendicular bearing, the weight of the body ſoon inclines it which way we deſign; whereas, in raiſing us erect, this great weight muſt be more than counteracted. 4. In calculating the force exerted by the muſcles which move the ſpine, we ſhould always make allowance for the action of the cartilages between the *vertebræ*, which, in every motion from an erect poſture, muſt be ſtretched on one ſide, and compreſſed on the other, to both which they reſiſt; whereas, in raiſing the trunk, theſe cartilages aſſiſt by their ſpringy force (*l*). 5. We are hence naturally led into the reaſon of

(*i*) Galen de uſu part. lib. 12. cap. 12.

(*k*) Paaw de oſſib. par. 2. cap. 2.

(*l*) Borelli de motu animal. pars 1. ſchol. ad propoſ. 58.—Parent. Hiſtoire de l'acad. des ſciences, 1702.

of our height of ſtature increaſing in the morning, and diminiſhing at night (*m*): for the intermediate cartilages of the *vertebræ* being preſſed all day long by the weight of our body, become more compact and thin in the evening; but when they are relieved from this preſſure in the night, they again expand themſelves to their former thickneſs; and ſeeing the bulk of any part muſt vary according to the different diſtenſion or repletion of the veſſels compoſing it, we may underſtand how we become taller after a plentiful meal, and decreaſe after faſting or evacuations (*n*). 6. From the different articulations of the bodies, and oblique proceſſes of the *vertebræ*, and the different ſtrength of the ligaments, it is plain, that they are formed ſo as to allow much larger motion forwards than backwards; this laſt being of much leſs uſe, and might be dangerous, by overſtretching the large blood-veſſels that are contiguous to the bodies of the *vertebræ* (*o*). 7. The intervertebral cartilages ſhrivelling as they become more ſolid by age, is the cauſe why old people generally bow forwards, and cannot raiſe their bodies to ſuch an erect poſture as they had in their youth.

The *true vertebræ* ſerve to give us an erect poſture; to allow ſufficient and ſecure motion to the head, neck, and trunk of the body; and to ſupport and defend the bowels, and other ſoft parts.

At the ordinary time of birth, each *vertebra* conſiſts of three bony pieces, connected by cartilages; to wit, the *body*, which is not fully oſſified, and a long crooked bone on each ſide: on which we ſee a ſmall ſhare of the bony bridge, the oblique proceſſes compleat, the beginning tranſverſe proceſſes, and the oblique plate, but no ſpinal proceſſes; ſo that the teguments are in no danger of being hurt by the ſharp ends of theſe ſpinal proceſſes, while a child is in its bended

(*m*) Waſſe Philoſoph. tranſact. numb. 383. art. 1.
(*n*) Abbe Fontenu Hiſtoire de l'acad. des ſciences, 1725.
(*o*) Galen de uſu part. lib. 1. cap. 16.

bended posture in the womb, nor while it is squeezed in the birth.

From this general mechanism of the spine, an account is easily deduced of all the different preternatural curvatures which the spine is capable of: for if one or more *vertebræ*, or their cartilages, are of unequal thickness in opposite sides, the spine must be reclined over to the thinner side; which now sustaining the greatest share of the weight, must still be more compressed, consequently hindered from extending itself in proportion to the other side, which, being too much freed of its burden, has liberty to enjoy a luxuriant growth. The causes on which such an inequality of thickness in different sides of the *vertebræ* depends, may vary: for, either it may be owing to an over-distension of the vessels of one side, and from thence a preternatural increase of the thickness of that part; or, which more commonly is the case, it may proceed from an obstruction of the vessels, by which the application of proper nourishment to the bony substance is hindered, whether that obstruction depends on the faulty disposition of the vessels or fluids; or if it is produced by an unequal mechanical pressure, occasioned by a paralytic weakness of the muscles and ligaments, or by a spasmodic over-action of the muscles on any side of the spine, or by people continuing long, or putting themselves frequently into any posture declining from the erect one: In all these cases, one common effect follows, to wit, the *vertebræ*, or their cartilages, or both, turn thick on that side where the vessels are free, and remain thin on the other side where the vessels are straitened or obstructed. —Whenever any morbid curvature is thus made, a second turn, but in an opposite direction to the former, must be formed; both because the muscles on the convex side of the spine being stretched, must have a stronger natural contraction to draw the parts to which their ends are fixed, and because the patient makes efforts to keep the centre of gravity of the body perpendicular to its base, that the muscles may be relieved

relieved from a conſtant violent contractile ſtate, which always creates uneaſineſs and pain.

When once we underſtand how theſe crooked ſpines are produced, there is little difficulty in forming a juſt prognoſis; and a proper method of cure may be eaſily contrived, which muſt vary as to the internal medicines, according to the different cauſes on which the diſeaſe depends. But one general indication muſt be purſued by ſurgeons; which is, to counteract the bending force, by increaſing the compreſſion on the convex part of the curvature, and diminiſhing it on the concave ſide; the manner of executing which in particular caſes muſt be different, and requires a very accurate examination of the circumſtances both of the diſeaſe and patient. In many ſuch caſes, I have found ſome ſimple directions, as to poſtures in which the patient's body ſhould be kept, of very great advantage.

Though the *true vertebræ* agree in the general ſtructure which I have hitherto deſcribed; yet, becauſe of ſeveral ſpecialities proper to a particular number, they are commonly divided into three claſſes, *viz. cervical, dorſal*, and *lumbar*.

The *cervical* (*a*) are the ſeven uppermoſt *vertebræ*; which are diſtinguiſhed from the reſt by theſe marks.—Their bodies are ſmaller and more ſolid than any others, and flatted on the fore-part, to make way for the *œſophagus*; or rather this flat figure is owing to the preſſure of that pipe, and to the action of the *longi colli* and anterior *recti* muſcles.—They are alſo flat behind, where ſmall proceſſes riſe, to which the internal ligaments are fixed.—The upper ſurface of the body of each *vertebra* is made hollow, by a ſlanting thin proceſs which is raiſed on each ſide:—The lower ſurface is alſo excavated, but in a different manner; for here, the poſterior edge is raiſed a little, and the one before is produced a conſiderable way.—Hence we ſee how the cartilages between thoſe bones are firmly connected, and their articulations are ſecure.

The

(*a*) Τραχηλυ, αυχης, colli.

The cartilages between thefe *vertebræ* are thick, efpecially at their fore-part; which is one reafon why the *vertebræ* advance forward as they defcend, and have larger motion.

The oblique proceffes of thefe bones of the neck more juftly deferve that name than thofe of any other *vertebræ*. They are fituated flanting; the upper ones having their fmooth and almoft flat furfaces facing obliquely backwards and upwards, while the inferior oblique proceffes have thefe furfaces facing obliquely forwards and downwards.

The tranfverfe proceffes of thefe *vertebræ* are framed in a different manner from thofe of any other bones of the fpine: For, befides the common tranfverfe procefs rifing from between the oblique proceffes of each fide, there is a fecond one that comes out from the fide of the body of each *vertebra*; and thefe two proceffes, after leaving a circular hole for the paffage of the cervical artery and vein, unite, and are confiderably hollowed at their upper part, with rifing fides, to protect the nerves that pafs in the hollow; and at laft each fide terminates in an obtufe point, for the infertion of mufcles.

The fpinal proceffes of thefe cervical bones ftand nearly ftraight backwards, are fhorter than thofe of any other *vertebræ*, and are forked or double at their ends; and hence allow a more convenient infertion to mufcles.

The thick cartilages between the bodies of thefe *cervical vertebræ*, the obliquity of their *oblique* proceffes, and the fhortnefs and horizontal fituation of their *fpinal* proceffes, all confpire to allow them large motion.

The holes between the bony crofs bridges, for the paffage of the nerves from the *fpinal marrow*, have their largeft fhare formed in the loweft of the two *vertebræ*, to which they are common.

So far moft of the cervical *vertebræ* agree; but they have fome particular differences, which oblige us to confider them feparately.

The

The firſt, from its uſe of ſupporting the head, has he name of *atlas* (a); and is alſo called *epiſtrophea*, rom the motion it performs on the ſecond.

The *atlas*, contrary to all the other *vertebræ* of the pine, has no body; but, inſtead of it, there is a boy arch.—In the convex fore-part of which, a ſmall ſing appears, where the *muſculi longi colli* are inſert-l; and, on each ſide of this protuberance, a ſmall avity may be obſerved, where the *recti interni mino-s* take their riſe.—The upper and lower parts of the ch are rough and unequal, where the ligaments that onnect this *vertebra* to the *os occipitis*, and to the ſe-ond *vertebra*, are fixed.—The back-part of the arch concave, ſmooth, and covered with a cartilage, in a cent ſubject, to receive the tooth-like proceſs of e ſecond *vertebra*.—In a firſt *vertebra*, from which e ſecond has been ſeparated, this hollow makes the ſſage for the *ſpinal* marrow to ſeem much larger an it really is: On each ſide of it a ſmall rough ſi-oſity may be remarked, where the ligaments going the ſides of the tooth-like proceſs of the following *rtebra* are faſtened; and on each ſide, a ſmall rough otuberance and depreſſion is obſervable, where the nſverſe ligament, which ſecures the tooth-like pro-ſs in the ſinuoſity, is fixed, and hinders that pro-ſs from injuring the *medulla ſpinalis* in the flections the head.

The *atlas* has as little ſpinal proceſs as body; but, itead thereof, there is a large bony arch, that the uſcles which paſs over this *vertebra* at that place ght not be hurt in extending the head. On the ck and upper part of this arch there are two de-eſſions where the *recti poſtici minores* take their riſe; d at the lower part are two other ſinuoſities, into ich the ligaments which connect this bone to the llowing one are fixed.

The ſuperior oblique proceſſes of this *atlas* are large, ong, hollow, and more horizontal than in any other *tebra*.—They riſe more in their external than inter-

(a) Αςραγαλος.

nal brim; by which their articulations with the *condyloid* processes of the *os occipitis* are firmer.—Under the external edge of each of these oblique processes, is the *fossa* or deep open channel, in which the vertebral arteries make the circular turn, as they are about to enter the great *foramen* of the occipital bone, and where the tenth pair of nerves goes out.—In several bodies, I have seen this *fossa* covered with bone.—The inferior oblique processes extending from within outwards and downwards, are large, concave, and circular. So that this *vertebra*, contrary to the other six, receives the bones with which it is articulated both above and below.

The transverse processes here are not much hollowed or forked, but are longer and larger than those of any other *vertebra* of the neck, for the origin and insertion of several muscles; of which those that serve to move this *vertebra* on the second, have a considerable lever to act with, because of the distance of their insertion from the *axis* of revolution.

The hole for the *spinal marrow* is larger in this than in any other *vertebra*, not only on account of the *marrow* being largest here, but also to prevent its being hurt by the motions of this *vertebra* on the second one.—This large hole, and the long transverse processes, make this the broadest *vertebra* of the neck.

The *condyles* of the *os occipitis* move forwards and backwards in the superior oblique processes of this *vertebra*; but from the figure of the bones forming these joints, it appears, that very little motion can here be allowed to either side; and there must be still less circular motion.

In new-born children, this *vertebra* has only the two lateral pieces ossified; the arch, which it has at its fore-part instead of a body, being cartilaginous.

The second *vertebra colli* is called *dentata*, from the tooth-like process on the upper part of its body. Some authors call it *epistrophea*, but improperly, since this designation is only applicable to the first, which moves on this as on an axis.

Th

The body of this *vertebra* is ſomewhat of a pyra-
nidal figure, being large, and produced downwards,
ſpecially at its fore-ſide, to enter into a hollow of
he *vertebra* below; while the upper part has a ſquare
rocefs with a ſmall point ſtanding out from it. This
t is that is imagined to reſemble a tooth (*a*), and
as given name to the *vertebra*.—The ſide of this
rocefs, on which the hollow of the anterior arch of
he firſt *vertebra* plays, is convex, ſmooth, and cover-
d with a cartilage; and it is of the ſame form be-
ind, for the ligament, which is extended tranſverſe-
y from one rough protuberance of the firſt *vertebra*
o the other, and is cartilaginous in the middle, to
nove on it.—A ligament likewiſe goes out in an ob-
ique tranſverſe direction, from each ſide of the *pro-
eſſus dentatus*, to be fixed at its other end to the firſt
ertebra, and to the occipital bone: And another li-
ament riſes up from near the point of the proceſs to
he *os occipitis*.

The ſuperior oblique proceſſes of this *vertebra den-
ata* are large, circular, very nearly in an horizontal
oſition, and ſlightly convex, to be adapted to the
nferior oblique proceſſes of the firſt *vertebra*.—A
noveable cartilage is ſaid by ſome authors to be in-
erpoſed between theſe oblique proceſſes of the firſt
nd ſecond *vertebra*; but I could never find it.—
he inferior oblique proceſſes of this *vertebra dentata*
nſwer exactly to the deſcription given of thoſe com-
non to all the cervical *vertebræ*.

The tranſverſe proceſſes of the *vertebra dentata* are
hort, very little hollowed at their upper part, and
ot forked at their ends; and the canals through
vhich the cervical arteries paſs, are reflected out-
vards about the middle ſubſtance of each proceſs;
o that the courſe of theſe veſſels may be directed to-
vards the tranſverſe proceſſes of the firſt *vertebra*.—
Had this curvature of the arteries been made in a
art ſo moveable as the neck is, while they were not
efended by a bone, and fixed to that bone, ſcarce a

 motion

(*a*) Conoides, pyrenoides, odontoides.

motion could have been performed without the utmoſt hazard of compreſſion, and a ſtop put to the courſe of the liquids, with all its train of bad conſequences. Hence we obſerve this ſame mechaniſm ſeveral times made uſe of, when there is any occaſion for a ſudden curvature of a large artery. This is the third remarkable inſtance of it we have ſeen. The firſt was the paſſage of the *carotids* through the *temporal* bones; and the ſecond was that lately deſcribed in the vertebral arteries, turning round the oblique proceſſes of the firſt *vértebra*, to come at the great hole of the occipital bone.

The ſpinal proceſs of this *vertebra dentata* is thick, ſtrong, and ſhort, to give ſufficient origin to the *muſculi recti majores*, and *obliqui inferiores*, and to prevent the contuſion of theſe and other muſcles in pulling the head back.

This ſecond *vertebra* conſiſts, at the birth, of four bony pieces: For, beſides the three which I already mentioned as common to all the *vertebræ*, the toothlike proceſs of this bone is begun at this time to be oſſified in its middle, and is joined as an appendix to the body of the bone.—Leſt this appendix be bended or diſplaced, nurſes ought to keep the heads of new-born children from falling too far backwards by *ſtay-bands*, or ſome ſuch means, till the muſcles attain ſtrength ſufficient to prevent that dangerous motion.

When we are acquainted with the ſtructure and articulations of the firſt and ſecond *vertebræ*, and know exactly the ſtrength and connection of their ligaments, there is no difficulty in underſtanding the motions that are performed upon or by the firſt; though this ſubject was formerly matter of hot diſpute among ſome of the greateſt anatomiſts (*b*). It is none of my purpoſe at preſent to enter into a detail of the reaſons advanced by either party; but to explain the fact, as any one may ſee it, who will remove the muſcles, which, in a recent ſubject, hinder the

(*b*) See Euſtach. de motu capitis.

the view of these two joints, and then will turn the head into all the different positions it is capable of. The head may then be seen to move forwards and backwards on the first *vertebra*, as was already said, while the *atlas* performs the *circumgyratio* upon the second *vertebra*; the inferior oblique processes of the first *vertebra* shuffling easily in a circular way on the superior oblique processes of the second, and its body or anterior arch having a rotation on the tooth-like process, by which the perpendicular ligament that is sent from the point of the tooth-like process to the occipital bone is twisted, while the lateral ligaments, that fix the *processus dentatus* to the sides of the first *vertebra*, and to the *os occipitis*, are very differently affected; for the one upon the side towards which the face is turned by the *circumgyratio*, is much shortened and lax, while the opposite one is stretched and made tense, and, yielding at last no more, prevents the head from turning any farther round on this *axis*. So that these lateral ligaments are the proper *moderators* of the *circumgyratio* of the head here, which must be larger or smaller, as these ligaments are weaker or stronger, longer or shorter, and more or less capable of being stretched.—Besides the revolution on this *axis*, the first *vertebra* can move a small way to either side; but is prevented from moving backwards and forwards, by its anterior arch, and by the cross ligament, which are both closely applied to the tooth-like process. Motion forwards here, would have been of very bad consequence, as it would have brought the beginning of the *spinal* marrow upon the point of the tooth-like process.

The rotatory motion of the head is of great use to us on many accounts, by allowing us to apply quickly our organs of the senses to objects: And the *axis* of rotation was altogether proper to be at this place; for, if it had been at a greater distance from the head, the weight of the head, if it had at any time been removed from a perpendicular bearing to the

ſmall very moveable joint, and thereby had acquired a long lever, would have broke the ligaments at every turn inconſiderately performed; or theſe ligaments muſt have been formed much ſtronger than could have been connected to ſuch ſmall bones. Neither could this circular motion be performed on the firſt *vertebra* without danger, becauſe the immoveable part of the *medulla oblongata* is ſo near, as at each large turn, the beginning of the *ſpinal* marrow would have been in danger of being twiſted, and of ſuffering by the compreſſion this would have made on its tender fibrils.

It is neceſſary to obſerve, that the *lateral* or *moderator* ligaments confine ſo much the motion of the firſt *vertebra* upon the ſecond, that, though this joint may ſerve us on ſeveral occaſions, yet we are often obliged to turn our faces farther round, than could be done by this joint alone, without the greateſt danger of twiſting the ſpinal marrow too much, and alſo of luxating the oblique proceſſes; therefore, in large turns of this kind, the rotation is aſſiſted by all the *vertebræ* of the neck and loins; and if this is not ſufficient, we employ moſt of the joints of the lower extremities.—This combination of a great many joints towards the performance of one motion, is alſo to be obſerved in ſeveral other parts of the body; notwithſtanding ſuch motions being generally ſaid to be performed by ſome ſingle joint only.

The third *vertebra* of the neck is by ſome called *axis;* but this name is applied to it with much leſs reaſon than to the ſecond.—This third, and the three below, have nothing particular in their ſtructure; but all their parts come under the general deſcription formerly given, each of them being larger as they deſcend.

The ſeventh (*c*) *vertebra* of the neck is near to the form of thoſe of the back, having the upper and lower ſurfaces of its body leſs hollow than the others:—The oblique proceſſes are more perpendicular;

(*c*) Atlas quibuſdam, maximà, magna vertebra, prominens.

ar;—neither ſpinal nor tranſverſe proceſſes are fork-d.—This ſeventh and the ſixth *vertebra* of the neck ave the hole in each of their tranſverſe proceſſes nore frequently divided by a ſmall croſs bridge, that oes between the cervical vein and artery, than any f the other *vertebræ*.

The twelve *dorſal* (*d*) may be diſtinguiſhed from he other *vertebræ* of the ſpine by the following narks.

Their bodies are of a middle ſize, betwixt thoſe of he neck and loins;—they are more convex before han either of the other two ſorts; and are flatted aterally by the preſſure of the ribs, which are inſert-d into ſmall cavities formed in their ſides. This atting on their ſides, which makes the figure of heſe *vertebræ* almoſt an half oval, is of good uſe; as : affords a firm articulation to the ribs, allows the *rachea arteria* to divide at a ſmall angle, and the o-her large veſſels to run ſecure from the action of the ital organs.—Theſe bodies are more concave behind han any of the other two claſſes.—Their upper and ower ſurfaces are horizontal.

The cartilages interpoſed between the bodies of heſe *vertebræ* are thinner than in any other of the *rue vertebrae*; and contribute to the concavity of he ſpine in the thorax, by being thinneſt at their ore-part.

The *oblique* proceſſes are placed almoſt perpendicu-ar; the upper ones ſlanting but a little forwards, nd the lower ones ſlanting as much backwards.—They have not as much convexity or concavity as is vorth remarking.—Between the oblique proceſſes of ppoſite ſides, ſeveral ſharp proceſſes ſtand out from he upper and lower parts of the plates which join to orm the ſpinal proceſs; into theſe ſharp proceſſes trong ligaments are fixed, for connecting the *ver-ebræ*.

The

(*d*) Θωρακος, μεταφρινυ, νωτυ, ὑποτραχηλιυ, antiſterni, pectoris, rgi.

The *tranſverſe* proceſſes of the *dorſal vertebrae* are long, thicker at their ends than in the middle, and turned obliquely backwards; which may be owing to the preſſure of the ribs, the tubercles of which are inſerted into a depreſſion near the end of theſe proceſſes.

The *ſpinal* proceſſes are long, ſmall-pointed, and ſloping downwards and backwards; from their upper and back-part a ridge riſes, which is received by a ſmall channel in the fore-part of the ſpinal proceſs immediately above, which is here connected to it by a ligament.

The *conduit* of the *ſpinal* marrow is here more circular, but, correſponding to the ſize of that cord, is ſmaller than in any of the other *vertebrae*, and a larger ſhare of the holes in the bony bridges, for the tranſmiſſion of the nerves, is formed in the *vertebra* above, than in the one below.

The connection of the *dorſal vertebrae* to the ribs, the thinneſs of their cartilages, the erect ſituation of the oblique proceſſes, the length, ſloping, and connection of the ſpinal proceſſes, all contribute to reſtrain theſe *vertebrae* from much motion, which might diſturb the actions of the heart and lungs; and, in conſequence of the little motion allowed here, the *intervertebral* cartilages ſooner ſhrivel, by becoming more ſolid: And therefore, the firſt remarkable curvature of the ſpine obſerved, as people advance to old age, is in the leaſt-ſtretched *vertebrae* of the back; or old people firſt become round-ſhouldered.

The bodies of the four uppermoſt *dorſal vertebræ* deviate from the rule of the *vertebræ* becoming larger as they deſcend; for the firſt of the four is the largeſt, and the other three below gradually become ſmaller, to allow the *trachea* and large veſſels to divide at ſmaller angles.

The two uppermoſt *vertebræ* of the back, inſtead of being very prominent forwards, are flatted by the action of the *muſculi longi colli* and *recti majores*.

The

The proportional ſize of the two little depreſſions n the body of each *vertebra*, for receiving the heads f the ribs, ſeems to vary in the following manner; he depreſſion on the upper edge of each *vertebra* de-reaſes as far down as the fourth, and after that in-reaſes.

The tranſverſe proceſſes are longer in each lower *ertebra* to the ſeventh or eighth, with their ſmooth urfaces, for the tubercles of the ribs, facing gradu-lly more downwards; but afterwards as they deſcend hey become ſhorter, and the ſmooth ſurfaces are di-ected more upwards.

The ſpinous proceſſes of the *vertebræ* of the back ecome gradually longer and more ſlanting from the rſt, as far down as the eighth or ninth *vertebra*; om which they manifeſtly turn ſhorter and more ect.

The firſt (*f*) *vertebra*, beſides an oblong hollow in s lower edge, that aſſiſts in forming the cavity herein the ſecond rib is received, has the whole ca-ty for the head of the firſt rib formed in it.

The ſecond has the name of *axillary* (*g*), without ny thing particular in its ſtructure.

The eleventh (*h*) often has the whole cavity for the eventh rib in its body, and wants the ſmooth ſur-ce on each tranſverſe proceſs.

The twelfth (*i*) always receives the whole head of e laſt rib, and has no ſmooth ſurface on its tranſ-erſe proceſſes, which are very ſhort.—The ſmooth rfaces of its inferior oblique proceſſes face outwards the *lumbar* do.—And we may ſay, in general, that e upper *vertebræ* of the back loſe gradually their ſemblance to thoſe of the neck, and the lower ones me nearer to the figure of the *lumbar*.

The articulation of the *vertebræ* of the back with e ribs, ſhall be more particularly conſidered, after e ribs are deſcribed. Only it may be proper now to

(*f*) Λοφια, gutturalis.
(*g*) Μασχαλιστηρ.
(*h*) Αρρεπης, in neutram partem inclinans.
(*i*) Διαζωστηρ, præcingens.

to remark, that the ligaments which ſerve that articulation aſſiſt in connecting the *vertebræ*.

The loweſt order of the *true vertebræ* is the *lumbar* (*k*), which are five bones, that may be diſtinguiſhed from any others by theſe marks: 1. Their bodies, though of a circular form at their fore-part, are ſomewhat oblong from one ſide to the other; which may be occaſioned by the preſſure of the large veſſels, the *aorta* and *cava*, and of the *viſcera*. The *epiphyſes* on their edges are larger, and therefore the upper and lower ſurfaces of their bodies are more concave than in the *vertebræ* of the back. 2. The cartilages between theſe *vertebræ* are much the thickeſt of any, and render the ſpine convex within the *abdomen*, by their greateſt thickneſs being at their fore-part. 3. The oblique proceſſes are ſtrong and deep; thoſe in oppoſite ſides being almoſt placed in parallel planes; the ſuperior, which are concave, facing inwards, and the convex inferior ones facing outwards: and therefore each of theſe *vertebræ* receives the one above it, and is received by the one below; which is not ſo evident in the other two claſſes already deſcribed. 4. Their tranſverſe proceſſes are ſmall, long, and almoſt erect, for allowing large motion to each bone, and ſufficient inſertion to muſcles, and for ſupporting and defending the internal parts. 5. Betwixt the roots of the ſuperior oblique and tranſverſe proceſſes, a ſmall protuberance may be obſerved, where ſome of the muſcles that raiſe the trunk of the body are inſerted. 6. Their ſpinal proceſſes are ſtrong, ſtraight, and horizontal, with broad flat ſides, and a narrow edge above and below; this laſt being depreſſed on each ſide by muſcles. And at the root of theſe edges, we ſee rough ſurfaces for fixing the ligaments. 7. The canal for the numerous cords, called *cauda equina*, into which the ſpinal marrow divides, is rather larger in theſe bones than what contains that *marrow* in the *vertebræ* of the back. 8. The holes for the paſſage of the nerves are more equally formed

(*k*) Οσφυος ιξυος, ψοιων, renum, lumborum.

ed out of both the contiguous *vertebræ* than in the other claſſes; the upper one furniſhes however the larger ſhare of each hole.

The thick cartilages between theſe *lumbar vertebræ*, their deep oblique proceſſes, and their erect ſpinal proceſſes, are all fit for allowing large motion; though it is not ſo great as what is performed in the neck; which appears from comparing the arches which the head deſcribes when moving on the neck, or the loins only.

The *lumbar vertebræ* as they deſcend, have their oblique proceſſes at a greater diſtance from each other, and facing more backwards and forwards.

Both tranſverſe and ſpinal proceſſes of the middlemoſt *vertebræ* of the loins are longeſt and thickeſt; in the *vertebræ* above and below they are leſs: So that theſe proceſſes of the firſt (*l*) and fifth (*m*) are the leaſt, to prevent their ſtriking on the ribs or *oſſa ilium*, or their bruiſing the muſcles in the motions of the ſpine.

The *epiphyſes* round the edges of the bodies of the *lumbar vertebræ* are moſt raiſed in the two loweſt, which conſequently make them appear hollower in the middle than the others are.

The body of the fifth *vertebra* is rather thinner than that of the fourth.—The ſpinal proceſs of this fifth is ſmaller, and the oblique proceſſes face more backwards and forwards than in any other *lumbar vertebra*.

After conſidering the ſtructure of the particular *vertebræ*, and their mutual connection, we may obſerve a ſolicitous care taken that they ſhall not be disjoined, but with great difficulty; for beſides being connected by ſtrong ligaments proportioned to the forces which are to be reſiſted, their bodies either enter ſo into each other, as to prevent their being diſplaced any way, as in the *vertebrae* of the neck; or they are propped on all ſides, as theſe of the *back* are by

(*l*) Νεφριτης, renalis.
(*m*) Ασχαλιτης, fulciens.

by the ribs; or their furfaces of contact are fo broad, as to render the feparation almoft impracticable, as in the *loins;* while the depth and articulation of the oblique proceffes are exactly proportioned to the quantity of motion which the other parts of the bones allow, or the mufcles can perform: Yet, as thefe oblique proceffes are fmall, and therefore not capable of fo fecure a conjunction, as the larger bodies, they may fooner yield to a disjoining force; but then their diflocation is not of near fo bad confequence as the feparation of the bodies would be. For, by the oblique proceffes being diflocated, the mufcles, ligaments, and *fpinal* marrow, are indeed ftretched; but this marrow muft be compreffed, or entirely deftroyed, when the body of the *vertebra* is removed out of its place.

The *FALSE VERTEBRÆ* compofe the under pyramid of the *fpine.* They are diftinguifhed from the bones already defcribed juftly enough by this epithet of *falfe;* becaufe though each bone into which they can be divided in young people, refembles the *true vertebrae* in figure, yet none of them contribute to the motion of the trunk of the body; they being intimately united to each other in adults, except at the lower part, where they are moveable; whence they are commonly divided into two bones, *os facrum* and *coccygis.*

OS SACRUM (*n*), is fo called, from being offered in facrifice by the ancients, or rather becaufe of its largenefs in refpect of the other *vertebrae.*——This bone is of an irregular triangular fhape, broad above, narrow below, convex behind, for the advantageous origin of the mufcles that move the *fpine* and thigh backwards; and concave behind, for enlarging the cavity of the *pelvis.*—Four tranfverfe lines, of a colour different from the reft of the bone which are feen on its fore-part, are the marks of divifion of the five

(*n*) Ιερον, σπονδυλος μεγας Hippocrat. ὑποσπονδυλον, oribas; Πλατυ, latum, os clunium, clavium.

ve different bones of which it confifts in young per-
ons.

The fore-part of the *os facrum*, analogous to the odies of the *true vertebrae*, is fmooth and flat, to al-ow a larger fpace for the contained bowels, without ny danger of hurting them; or this flat figure may e owing to the equal preffure of thefe bowels, par-cularly of the laft gut.—The back-part of it is al-ioft ftraight, without fo large a cavity as the *verte-rae* have; becaufe the fpinal marrow, now feparated ito the *cauda equina*, is fmall.—The bridges between ie bodies and proceffes of this bone, are much iicker, and in proportion fhorter, than in the former afs of bones.—The ftrength of thefe crofs bridges very remarkable in the three upper bones, and is ell proportioned to the incumbent weight of the unk of the body, which thefe bridges fuftain in a anfverfe, confequently an unfavourable fituation, hen the body is erect.

There are only two oblique proceffes of the *os fa-um*; one ftanding out on each fide from the upper rt of the firft bone.——Their plain erect furfaces ce backwards, and are articulated with the inferior lique proceffes of the laft *vertebra* of the loins, to hich each of thefe proceffes is connected by a ftrong ament, which rifes from a fcabrous cavity round eir roots, where mucilaginous glands are alfo lodg-.—Inftead of the other oblique proceffes of this ne, four rough tubercles are to be feen on each e of its furface behind, from which the *mufculus er* has its origin.

The tranfverfe proceffes here are all grown toge-er into one large ftrong oblong procefs on each e, which, fo far as it anfwers to the firft three nes, is very thick, and divided into two irregular vities, by a long perpendicular ridge.—The fore-oft of the two cavities has commonly a thin carti-inous fkin covering it in the recent fubject, and is pted to the unequal protuberance of the *os ilium*; l a ftrong ligament connects the circumference of

these surfaces of the two bones.—The cavity behind is divided by a transverse ridge into two, where strong ligamentous strings that go from this bone to the *os ilium*, with a cellular substance containing *mucus*, are lodged.

The transverse processes of the two last bones of the *os sacrum* are much smaller than the former.—At their back-part, near their edge, a knob and oblong flat surface give rise to two strong ligaments which are extended to the *os ischium;* and are therefore called *sacro-sciatic*.

The spinal processes of the three uppermost bones of the *os sacrum* appear short, sharp, and almost erect, while the two lower ones are open behind; and sometimes a little knob is to be seen on the fourth, though generally it is bifurcated, without the two legs meeting into a spine; in which condition also the first is often to be seen; and sometimes none of them meet, but leave a *sinus*, or rather *fossa*, instead of a canal (*o*).—The *musculus latissimus* and *longissimus dorsi*, *sacro-lumbalis* and *glutaeus maximus*, have part of their origins from these spinal processes.

The canal between the bodies and processes of this bone, for the *cauda equina*, is triangular; and becomes smaller as it descends, as the *cauda* also does.—Below the third bone, this passage is no more a complete bony canal, but is open behind; and is only there defended by a strong ligamentous membrane stretched over it, which, with the muscles that cover it, and are very prominent on each side, is a sufficient defence for the bundle of nerves within.

At the root of each oblique process of this bone the notch is conspicuous, by which, and such another in the last *vertebra* of the loins, a passage is left for the twenty-fourth spinal nerve; and, in viewing the *os sacrum*, either before or behind, four large holes appear in each side, in much the same height, as where the marks of the union of its several bones remain. Some of the largest nerves of the body pass throug

(*o*) Verheyen Anat. tract. 5. cap. 9.—Sue Trad. d'osteol. p. 127

through the anterior holes; and fuperficial grooves running outwards from them in different directions, fhew the courfe of thefe nerves.——From the intervals of thefe grooves, the *pyriformis* mufcle chiefly rifes.—The holes in the back-part of the bone are covered by membranes which allow fmall nerves to pafs through them.—The two uppermoft of thefe holes, efpecially on the fore-fide, are the largeft; and as the bone defcends, the holes turn fmaller. Sometimes a notch is only formed at the lower part in each fide of this bone; and in other fubjects there is a hole common to it and the *os coccygis*, through which the twenty-ninth pair of fpinal nerves paffes; and frequently a bony bridge is formed on the back-part of each fide by a procefs fent up from the back-part of the *os coccygis*, and joined to the little knobs which the laft bone of the *os facrum* has inftead of a fpinal procefs. Under this bridge or *jugum*, the twenty-ninth pair of fpinal nerves runs in its courfe to the common holes juft now defcribed.

The upper part of the body of the firft bone refembles the *vertebrae* of the loins; but the fmall fifth bone is oblong tranfverfely, and hollow in the middle of its lower furface.

The fubftance of the *os facrum* is very fpongy, without any confiderable folid external plates, and is lighter proportionally to its bulk than any other bone in the body; but is fecured from injuries by the thick mufcles that cover it behind, and by the ftrong ligamentous membranes that clofely adhere to it.—As this is one of the moft remarkable inftances of this fort of defence afforded a foft weak bone, we may make the general obfervation, That, where-ever we meet with fuch a bone, one or other, or both thefe defences are made ufe of, the firft to ward off injuries, and the fecond to keep the fubftance of the bone from yielding too eafily.

This bone is articulated above to the laft *vertebra* of the loins, in the manner that the *lumbar vertebrae* are joined; and therefore the fame motions may be per-

formed here.—The articulation of the lower part of the *os ſacrum* to the *os coccygis*, ſeems well enough adapted for allowing conſiderable motion to this laſt bone, was it not much confined by ligaments. Laterally, the *os ſacrum* is joined to the *oſſa ilium* by an immoveable *ſynchondroſis*, or what almoſt deſerves the name of a ſuture; for the cartilaginous cruſt on the ſurface of the bones is very thin, and both their ſurfaces are ſo ſcabrous and unequal, as to be indented into each other: which makes ſuch a ſtrong connection, that great force is required to ſeparate them, after all the muſcles and ligaments are cut.—Frequently the two bones grow together in old ſubjects.

The uſes of the *os ſacrum* are, to ſerve as the common baſe and ſupport of the trunk of the body, to guard the nerves proceeding from the end of the ſpinal marrow, to defend the back-part of the *pelvis*, and to afford ſufficient origin to the muſcles which move the trunk and thigh.

The bones that compoſe the *os ſacrum* of infants, have their bodies ſeparated from each other by a thick cartilage; and, in the ſame manner as the *true vertebrae*, each of them conſiſts of a body and two lateral plates, connected together by cartilages; the ends of the plates ſeldom being contiguous behind.

OS COCCYGIS (*a*), or *rump-bone*, is that triangular chain of bones depending from the *os ſacrum*; each bone becoming ſmaller as they deſcend, till the laſt ends almoſt in a point. The *os coccygis* is convex behind, and concave before; from which crooked pyramidal figure, which was thought to reſemble a cuckoo's beak, it has got its name.

This bone conſiſts of four pieces in people of middle age:—In children, very near the whole of it is cartilage: In old ſubjects, all the bones are united, and become frequently one continued bone with the *os ſacrum*.

The higheſt of the four bones is the largeſt, with ſhoulders extended farther to each ſide than the end of

(*a*) Ορροπυγιον ὀρρος, caudæ os, ſpondylium, os cuculi.

›f the *os ſacrum;* which enlargement ſhould, in my ›pinion, ſerve as a diſtinguiſhing mark to fix the imits of either bone; and therefore ſhould take away ll diſpute about reckoning the number of bones, f which one or other of theſe two parts of the *falſe ›ertebrae*, is compoſed; which diſpute muſt ſtill be ept up, ſo long as the numbering five or ſix bones n the *os ſacrum* depends upon the uncertain accident f this broad-ſhouldered little bone being united to r ſeparated from it.—The upper ſurface of this bone s a little hollow.—From the back of that bulbous ›art called its *ſhoulders*, a proceſs often riſes up on ach ſide, to join with the bifurcated ſpine of the ourth and fifth bones of the *os ſacrum*, to form the ony bridge mentioned in the deſcription of the *os ıcrum*.—Sometimes theſe ſhoulders are joined to the des of the fifth bone of the *os ſacrum*, to form the ole in each ſide common to theſe two bones, for the aſſage of the twenty ninth pair of ſpinal nerves.—mmediately below the ſhoulders of the *os coccygis*, a otch may be remarked in each ſide, where the thirieth pair of the ſpinal nerves paſſes.—The lower end f this bone is formed into a ſmall head, which very ften is hollow in the middle.

The three lower bones gradually become ſmaller, nd are ſpongy; but are ſtrengthened by a ſtrong liganent which covers and connects them.—Their ends, y which they are articulated, are formed in the ſame nanner as thoſe of the firſt bone are.

Between each of theſe four bones of young ſubects, a cartilage is interpoſed; therefore their articultion is analogous to that of the bodies of the *verebrae* of the neck: For, as has been above remarkd, the lower end of the *os ſacrum*, and of each of he three ſuperior bones of the *os coccygis*, has a ſmall epreſſion in the middle; and the upper part of all he bones of the *os coccygis* is a little concave, and onſequently the interpoſed cartilages are thickeſt in he middle, to fill up both cavities; by which they onnect the bones more firmly.—When the cartilages

oſſify, the upper end of each bone is formed into a cavity, exactly adapted to the protuberant lower end of the bone immediately above.—From this ſort of articulation, it is evident, that, unleſs when theſe bones grow together, all of them are capable of motion; of which, the firſt and ſecond, eſpecially this laſt, enjoys the largeſt ſhare.

The lower end of the fourth bone terminates in a rough point, to which a cartilage is appended.

To the ſides of theſe bones of the *os coccygis*, the *coccygaei* muſcles (*b*), and part of the *levatores ani*, and of the *glutaei maximi*, are fixed.

The ſubſtance of theſe bones is very ſpongy, and in children cartilaginous; there being only a part of the firſt bone oſſified in a new-born infant.—Since therefore the *inteſtinum rectum* of children is not ſo firmly ſupported as it is in *adults*, this may be one reaſon why they are more ſubject to a *procidentia ani* than old people (*c*).

From the deſcription of this bone, we ſee how little it reſembles the *vertebrae*; ſince it ſeldom has proceſſes, never has any cavity for the *ſpinal* marrow, nor holes for the paſſage of nerves.—Its connection hinders it to be moved to either ſide; and its motion backwards and forwards is much confined: Yet as its ligaments can be ſtretched by a conſiderable force, it is a great advantage in the excretion of the *foeces alvinae*, and much more in child-bearing, that this bone ſhould remain moveable: and the right management of it, in delivering women, may be of great benefit to them (*d*).—The mobility of the *os coccygis* diminiſhing as people advance in age, eſpecially when its ligaments and cartilages have not been kept flexible by being ſtretched, is probably one reaſon why the women, who are old maids before they marry, have generally hard labour in child-bed.

The

(*b*) Douglas, Myograph. chap. 40.—Euſtach. tab. 36. No. 45. 20.

(*c*) Spigel. de humani corp. fabric. lib. 2. cap. 22.—Paaw, de oſſib. par. 2. cap. 3.

(*d*) Paaw, ibid.—Deventer, Operat. chirurg. cap. 27.

The *os coccygis* ſerves to ſuſtain the *inteſtinum rectum*; and, in order to perform this office more effectually, it is made to turn with a curve forwards; by which alſo the bone itſelf, as well as the muſcles and teguments, is preſerved from any injury, when we ſit with our body reclined back.

The ſecond part of the trunk of the ſkeleton, the *PELVIS*, is the cylindrical cavity at the lower part of the *abdomen*, formed by the *os ſacrum*, *os coccygis*, and *oſſa innominata*; which laſt therefore fall now in courſe to be examined.

Though the name of *OSSA INNOMINATA* (*e*) contributes nothing to the knowledge of their ſituation, ſtructure or office; yet they have been ſo long and univerſally known by it, that there is no occaſion for changing it.—They are two large broad bones, which form the fore-part and ſides of the *pelvis*, and the lower part of the ſides of the *abdomen*.—In children each of theſe bones is evidently divided into three; which are afterwards ſo intimately united, that ſcarce the leaſt mark of their former ſeparation remains: This notwithſtanding, they are deſcribed as conſiſting each of three bones, to wit, the *os ilium*, *iſchium*, and *pubis;* which I ſhall firſt deſcribe ſeparately, and then ſhall conſider what is common to any two of them, or to all the three.

OS ILIUM (*f*), or *haunch-bone*, is ſituated higheſt of the three, and reaches as far down as one third of the great cavity into which the head of the thigh-bone is received.

The external ſide of this bone is unequally convex, and is called its *dorſum*;—the internal concave ſurface is by ſome (but improperly) named its *coſta*.—The ſemicircular edge at the higheſt part of this bone, which is tipped with a cartilage in the recent ſubject, is named the *ſpine*, into which the external or deſcending oblique muſcle of the *abdomen* is inſerted; and from it the internal aſcending oblique and the tranſverſe

(*e*) Σκελεον, προσφυσεις, ſacro conjuncta.

(*f*) Λαγονων, κενεων, ſcaphium, lumbare, clunium, clavium, anchas.

verſe muſcles of the belly, with the *glutæus maximus*, *quadratus lumborum*, and *latiſſimus dorſi*, have their origin. Some (*a*) are of opinion, that it is only the tendinous cruſt of all theſe muſcles, and not a cartilage, as commonly alledged, that covers this bony edge.—The ends of the ſpine are more prominent than the ſurface of the bone below them; therefore are reckoned proceſſes.—From the anterior ſpinal proceſs, the *ſartorius* and *faſcialis* muſcles have their riſe, and the outer end of the doubled tendon of the external oblique muſcle of the *abdomen*, commonly called *Fallopius*'s or *Poupart*'s ligament, is fixed to it.—The inſide of the poſterior ſpinal proceſs, and of part of the ſpine forward from that, is made flat and rough where the *ſacro-lumbalis* and *longiſſimus dorſi* riſe; and to its outſide ligaments, extended to the *os ſacrum* and tranſverſe proceſſes of the fifth and fourth *vertebrae* of the loins, are fixed (*b*).—Below the anterior ſpinal proceſs another protuberance ſtands out, which, by its ſituation, may be diſtinguiſhed from the former, by adding the epithet of *inferior*, where the *muſculus rectus tibiae* has its origin (*c*).—Betwixt theſe two anterior proceſſes the bone is hollowed where the beginning of the *ſartorius* muſcle is lodged.—Below the poſterior ſpinal proceſs, a ſecond protuberance of the edge of this bone is in like manner obſervable, which is cloſely applied to the *os ſacrum*.—Under this laſt proceſs a conſiderable large niche is obſervable in the *os ilium*; between the ſides of which and the ſtrong ligament that is ſtretched over from the *os ſacrum* to the ſharp-pointed proceſs of the *os iſchium* of the recent ſubject, a large hole is formed, through which the *muſculus pyriformis*, the great ſciatic nerve, and the poſterior crural veſſels paſs, and are protected from compreſſion.

The external broad ſide or *dorſum* of the *os ilium* is a little

(*a*) Winſlow, Expoſition anatomique du corps humain, traité des os frais, § 96.

(*b*) Weitbrecht, Syndeſmolog. ſect. 4. § 39. 40. 46. 47.

(*c*) Baker, Curſ. oſteolog. demonſtr. 3.

ı little hollow towards the ſore-part; farther back it s as much raiſed; then is conſiderably concave; and, aſtly, it is convex. Theſe inequalities are occaſion-:d by the actions of the muſcles that are ſituated on his ſurface.—From behind the uppermoſt of the two ınterior ſpinal proceſſes, in ſuch bones as are ſtrong-y marked by the muſcles, a ſemicircular ridge is ex-ended to the hollow paſſage of the ſciatic nerve. 3etween the ſpine and this ridge, the *glutaeus medius* akes its riſe. Immediately from above the loweſt of he anterior ſpinal proceſſes, a ſecond ridge is ſtretch-d to the niche. Between this and the former ridge, he *glutaeus minimus* has its origin.—On the outſide f the poſterior ſpinal proceſſes, the *dorſum* of the *os 'ium* is flat and rough, where part of the *muſculus lutaeus maximus* and *pyriformis* riſes.—The loweſt art of this bone is the thickeſt, and is formed into a ırge cavity with high brims, to aſſiſt in compoſing he great *acetabulum*; which ſhall be conſidered, after ll the three bones that conſtitute the *os innominatum*, re deſcribed.

The internal ſurface of the *os ilium* is concave in s broadeſt fore-part, where the internal iliac muſcle as its origin, and ſome ſhare of the *inteſtinum ilium* nd *colon* is lodged.—From this large hollow, a ſmall nuoſity is continued obliquely forwards, at the in-de of the anterior inferior ſpinal proceſs, where part f the *pſoas* and *iliacus* muſcles, with the crural veſ-ls and nerves, paſs.—The large concavity is bound-l below by a ſharp ridge, which runs from behind orwards; and being continued with ſuch another ridge f the *os pubis*, forms a line of partition between the *bdomen* and *pelvis*.—Into this ridge the broad tendon f the *pſoas parvus* is inſerted.

All the internal ſurface of the *os ilium*, behind this dge, is very unequal: For the upper part is flat, ut ſpongy, where the *ſacro-lumbalis* and *longiſſimus rſi* riſe.—Lower down, there is a tranſverſe ridge om which ligaments go out to the *os ſacrum*.—nmediately below this ridge, the rough unequal cavi-

ties

ties and prominences are placed, which are exactl adapted to thofe defcribed on the fide of the *os facrum.*—In the fame manner, the upper part of thi rough furface is porous, for the firmer adhefion o the ligamentous cellular fubftance; while the lowe part is more folid, and covered with a thin cartilagi nous fkin, for its immoveable articulation with th *os facrum.*—From all the circumference of this larg unequal furface, ligaments are extended to the *os facrum,* to fecure more firmly the conjunction of thef bones.

The paffages of the medullary veffels are very con fpicuous, both in the *dorfum* and *cofta* of many *off ilium*; but in others they are inconfiderable.

The pofterior and lower parts of thefe bones ar thick; but they are generally exceeding thin an compact at their middle, where they are expofed t the actions of the *mufculi glutaei* and *iliacus internus* and to the preffure of the bowels contained in th belly.—The fubftance of the *offa ilium* is moftly cellu lar, except a thin external table.

In a ripe child, the fpine of the *os ilium* is cartila ginous, and is afterwards joined to the bone in forn of an *epiphyfe.* The large lower end of this bone i not compleatly offified.

OS ISCHIUM (*d*) or *hip-bone,* is of a middle bull between the two other parts of the *os innominatum,* i fituated loweft of the three, and is of a very irregula figure.—Its extent might be marked by an horizon tal line drawn near through the middle of the *acetabulum*; for the upper bulbous part of this bone form fome lefs than the lower half of that great cavity, and the fmall leg of it rifes to much the fame height or the other fide of the great hole common to this bone and the *os pubis.*

From the upper thick part of the *os ifchium,* a fharp procefs, called by fome *fpinous,* ftands out backwards, from which chiefly the *mufculus coccygæus* and *fuperior gemellus,* and part of the *levator ani,* rife; and the anterior

(*d*) Coxæ, coxendicis, pixis.

nterior or internal *sacro-sciatic* ligament is fixed to :.—Between the upper part of this ligament and he bones, it was formerly observed that the *pyriform* nuscle, the posterior crural vessels, and the sciatic erve, pass out of the *pelvis*.——Immediately below his process a sinuosity is formed for the tendon of he *musculus obturator internus*.—-In a recent subject, his part of the bone, which serves as a pully on which the *obturator* muscle plays, is covered with a igamentous cartilage, that, by two or three small idges, points out the interstices of the fibres in the endon of this muscle.——The outer surface of the one at the root of this spinous process is made hol- ow by the *pyriformis* or *iliacus externus* muscle.

Below the sinuosity for the *obturator* muscle, is the reat knob or *tuberosity*, covered with cartilage or endon (*a*).—The upper part of the tuberosity gives ise to the inferior *gemellus* muscle.——To a ridge at he inside of this, the external or posterior *sacro-sciatic* igament is so fixed, that between it, the internal li- ament, and the sinuosity of the *os ischium*, a passage s left for the internal *obturator* muscle.—The upper hick smooth part of the *tuber*, called by some its *orsum*, has two oblique impressions on it. The in- ner one gives origin to the long head of the *biceps flexor tibiæ* and *seminervosus* muscles, and the *semi- membranosus* rises from the exterior one, which reaches igher and nearer the *acetabulum* than the other.—— The lower, thinner, more scabrous part of the knob which bends forwards, is also marked with two flat urfaces, whereof the internal is what we lean upon n sitting, and the external gives rise to the largest ead of the *triceps adductor femoris*.—Between the ex- ernal margin of the tuberosity and the great hole of he *os innominatum*, there is frequently an obtuse ridge xtended down from the *acetabulum*, which gives rigin to the *quadratus femoris*.——As the *tuber* ad- ances forwards, it becomes smaller, and is rough, or the origin of the *musculus transversalis* and *erector penis*.

(*a*) Winslow Exposition anat. des os frais, § 96.

penis.—The ſmall leg of it, which mounts upwards to join the *os pubis*, is rough and prominent at its edge, where the two lower heads of the *triceps* or *quadriceps adductor femoris* take their riſe.

The upper and back-part of the *os iſchium* is broad and thick; but its lower and fore-part is narrower and thinner.—Its ſubſtance is of the ſtructure common to broad bones.

The *os ilium* and *pubis* of the ſame ſide are the only bones which are contiguous to the *os iſchium*.

The part of the *os iſchium* which forms the *acetabulum*, the ſpinous proceſs, the great *tuber*, and the recurved leg, are all cartilaginous at birth.—The *tuber*, with part of the leg, or proceſs above it, becomes an epiphyſe before this bone is fully formed.

The *OS PUBIS* (*b*), or *ſhare-bone*, is the leaſt of the three parts of the *os innominatum*, and is placed at the upper fore-part of it.—The thick largeſt part of this bone is employed in forming the *acetabulum*; from which becoming much ſmaller, it is ſtretched inwards to its fellow of the other ſide, where again it grows larger, and ſends a ſmall branch downwards to join the end of the ſmall leg of the *os iſchium*.—The upper fore-part of each *os pubis* is tuberous and rough where the *muſculus rectus* and *pyramidalis* are inſerted.——From this a ridge is extended along the upper edge of the bone, in a continued line with ſuch another of the *os ilium*, which divides the *abdomen* and *pelvis*. The ligament of *Fallopius* is fixed to the internal end of this ridge; and the ſmooth hollow below it, is made by the *pſoas* and *iliacus internus* muſcles paſſing with the anterior crural veſſels and nerves behind the ligament.—Some way below the former ridge, another is extended from the tuberous part of the *os pubis* downwards and outwards towards the *acetabulum*; between theſe two ridges the bone is hollow and ſmooth, for lodging the head of the *pectineus* muſcle.——Immediately below, where the lower ridge is to take the turn downwards, a winding niche

(*b*) ἥβης, pectinis, penis, pudibundum, feneſtratum.

iche is made, which is comprehended in the great *oramen* of a ſkeleton, but is formed into a hole by a ıbtended ligament in the recent ſubject, for the paſ-ıge of the poſterior crural nerve, an artery, and a ein.—The internal end of the *os pubis* is rough and nequal, for the firmer adheſion of the thick liga-ıentous cartilage that connects it to its fellow of the ther ſide:—The proceſs which goes down from that) the *os iſchium* is broad and rough before, where ıe *gracilis* and upper heads of the *triceps*, or rather *uadriceps adductor femoris* have their origin.

The ſubſtance of the *os pubis* is the ſame as of o-ıer broad bones.

Only a part of the large end of this bone is oſſi-ed, and the whole leg is cartilaginous, in a child orn at the full time.

Betwixt the *os iſchium* and *pubis*, a very large irre-ılar hole is left, which, from its reſemblance to a oor or ſhield, has been called *thyroides*. This hole all, except the niche for the poſterior crural nerve, led up in a recent ſubject with a ſtrong ligament-ıs membrane, that adheres very firmly to its cir-ımference. From this membrane chiefly the two *turator* muſcles, external and internal, take their e.—The great deſign of this hole, beſides render-g the bone lighter, is to allow a ſtrong enough o-gin to the *obturator* muſcles, and ſufficient ſpace for dging their bellies, that there may be no danger of ſturbing the functions of the contained *viſcera* of e *pelvis* by the actions of the internal, nor of the ternal being bruiſed by the thigh-bone, eſpecially its leſſer *trochanter*, in the motions of the thigh wards: Both which inconveniencies muſt have hap-ned, had the *oſſa innominata* been complete here, d of ſufficient thickneſs and ſtrength to ſerve as the ed point of theſe muſcles.—The bowels ſometimes ıke their way through the niche for the veſſels, at e upper part of this *thyroid* hole, and this cauſes a *rnia* in this place (*c*).

O In

(c) Memoires de l'acad. de chirurgie, tom. 1. p. 709, &c.

In the external ſurface of the *oſſa innominata*, nea the outſide of the great hole, a large deep cavity i formed by all the three bones conjunctly: For the *o pubis* conſtitutes about one fifth; the *os ilium* make ſomething leſs than two-fifths, and the *os iſchium* a much more than two-fifths. The brims of this ca vity are very high, and are ſtill much more enlarge by the ligamentous cartilage, with which they ar tipped in a recent ſubject. From this form of th cavity it has been called *acetabulum;* and for a diſtin guiſhing character, the name of the bone that con ſtitutes the largeſt ſhare of it is added; therefore *ace tabulum oſſis iſchii* (*d*) is the name this cavity com monly bears.——Round the baſe of the *ſupercilia* th bone is rough and unequal, where the *capſular* liga ment of the articulation is fixed.—The brims at th upper and back-part of the *acetabulum* are much lar ger and higher than any where elſe; which is very ne ceſſary to prevent the head of the *femur* from ſlippin out of its cavity at this place, where the whol weight of the body bears upon it, and conſequentl would otherwiſe be conſtantly in danger of thruſtin it out.—As theſe brims are extended downwards an forwards, they become leſs; and at their interna lower part a breach is made in them; from the on ſide of which to the other, a ligament is placed i the recent ſubject; under which a large hole is left which contains a fatty cellular ſubſtance and veſſel The reaſon of which appearance has afforded matte of debate. To me it ſeems evidently contrived fo allowing a larger motion to the thigh inwards: Fo if the bony brims had been here continued, the nec of the thigh-bone muſt have ſtruck upon them whe the thighs were brought acroſs each other; which, i a large ſtrong motion this way, would have endan gered the neck of the one bone, or brim of the othe Then the veſſels which are diſtributed to the join may ſafely enter at the ſinuoſity in the bottom of th breach; which being however larger than is neceſ ſar

(*d*) Coxæ, coxendicis.

ry for that purpose, allows the large mucilaginous land of the joint to escape below the ligament, when e head of the thigh-bone is in hazard of pressing o much upon it in the motions of the thigh outards (*e*).——Besides this difference in the height of e brims, the *acetabulum* is otherwise unequal: For e lower internal part of it is depressed below the rtilaginous surface of the upper part, and is not overed with cartilage; into the upper part of this rticular depression, where it is deepest, and of a milunar form, the ligament of the thigh-bone, ommonly, though improperly, called the *round* one, inserted; while, in its more superficial lower part, e large mucilaginous gland of this joint is lodged. he largest share of this separate depression is formed the *os ischium*.

From what has been said of the condition of the ree bones composing this *acetabulum* in new-born hildren, it must be evident, that a considerable part this cavity is cartilaginous in them.

The *ossa innominata* are joined at their back-part to ch side of the *os sacrum* by a sort of suture, with a ry thin intervening cartilage, which serves as so uch glue to cement these bones together; and ong ligaments go from the circumference of this equal surface, to connect them more firmly. The a *innominata* are connected together at their forert by the ligamentous cartilage interposed between e two *ossa pubis*.—These bones can therefore have motion in a natural state, except what is common the trunk of the body, or to the *os sacrum*. But has been disputed, whether or not they loosen so uch from each other, and from the *os sacrum*, in ild-birth, by the flow of *mucus* to the *pelvis*, and the throws of the labour, as that the *ossa pubis* rede from each other, and thereby allow the passage tween the bones to be enlarged.—Several observaons (*f*) shew that this relaxation sometimes happens:

But

(*e*) Petit. Memoires de l'acad. des sciences, 1722.

(*f*) Bauhin. Theat. anat. lib. 1. cap. 49.—Spigel. Anat. lib. 2. p. 24.—Riolan. Anthropogr. lib. 6. cap. 12.—Diemerbroek Anat. . 9. cap. 16.

But thoſe who had frequently opportunities of diſſecting the bodies of women who died immediately after being delivered of children, teach us to beware of regarding this as the common effect of child-birth; for they found ſuch a relaxation in very few of the bodies which they examined (*b*).

Conſidering what great weight is ſupported in our erect poſture, by the articulation of the *oſſa innominata* with the *os ſacrum*, there is great reaſon to think that if the conglutinated ſurfaces of theſe bones were once ſeparated, (without which, the *oſſa pubis* cannot ſhuffle on each other), the ligaments would be violently ſtretched, if not torn; from whence many diſorders would ariſe (*c*).

Each *os innominatum* affords a ſocket (the *acetabulum*) for the thigh-bones to move in, and the trunk of the body rolls here ſo much on the heads of the thigh-bones, as to allow the moſt conſpicuous motions of the *trunk*, which are commonly thought to be performed by the bones of the ſpine.—This articulation is to be more fully deſcribed after the *oſſa femoris* are examined.

The *pelvis* then has a large open above where it is continued with the *abdomen*, is ſtrongly fenced by bones on the ſides, back, and fore-part, and appears with a wide opening below, in the ſkeleton; but, in the recent ſubject, a conſiderable part of the opening is filled by the *ſacro-ſciatic* ligaments, *pyriform*, *internal obturator*, *levatores ani*, *gemini*, and *coccygæi* muſcles, which ſupport and protect the contained parts better than bones could have done; ſo that ſpace is only left at the loweſt part of it, for the large excretories, the *veſica urinaria*, *inteſtinum rectum*, and in females, the *uterus*, to diſcharge themſelves.

The *THORAX* (*d*), or *cheſt*, which is the only part of the trunk of the body which we have not yet deſcribed,

(*b*) Hildan. Epiſt. cent. obſ. 46.—Dionis Sixieme demonſt. des os.—Morgagn. Adverſ. 3. animad. 15.

(*c*) Ludov. in Ephem. German. dec. 1. ann. 3. obſ. 255.

(*d*) Pectus, caſſum.

escribed, reaches from below the neck to the belly; nd, by means of the bones that guard it, is formed nto a large cavity: The figure of which is somewhat onoidal; but its upper smaller end is not finished, eing left open for the passage of the wind-pipe, gulet, and large blood-vessels; and its lower part, or ase, has no bones, and is shorter before than behind; o that, to carry on our comparison, it appears like an blique section of the conoid. Besides which we ught also to remark, that the lower part of this caity is narrower than some way above (*e*); and that he middle of its back-part is considerably diminished y the bones standing forwards into it.

The bones which form the *thorax*, are, the twelve orsal *vertebræ* behind, the ribs on the sides, and the *ernum* before.

The *vertebræ* have already been described as part of he spine; and therefore are now to be passed.

The *RIBS*, or *costæ (f)*, (as if they were *custodes*, r guards, to these principal organs of the animal achine, the heart and lungs), are the long rooked bones placed at the side of the chest, in n oblique direction downwards in respect of the ack-bone.—Their number is generally twelve on ach side; though frequently eleven or thirteen have een found (*g*).—Sometimes the ribs are found preernaturally conjoined or divided (*h*).

The ribs are all concave internally; where they re also made smooth by the action of the contained arts, which, on this account, are in no danger of eing hurt by them; and they are convex externally, hat they might resist that part of the pressure of the mosphere, which is not balanced by the air within he lungs, during *inspiration*.—The ends of the ribs ext the *vertebrae* are rounder than they are after these ones have advanced forwards, when they become

 flatter

(*e*) Albin. de offib. sect. 169.

(*f*) Πλευραι, περιστερνα, σπαθαι.

(*g*) Riolan. Comment. de ossibus, cap. 19.—Marchetti, cap. 9. Cowper Explicat. tab. 93. and 94.—Morgagn. Advers. anat.

(*h*) Sue Trad. d'osteolog. p. 141.

flatter and broader, and have an upper and lower edge, each of which is made rough by the action of the *intercostal* muscles, inserted into them. These muscles, being all of nearly equal force, and equally stretched in the interstices of the ribs, prevent the broken ends of these bones in a fracture from being removed far out of their natural place, to interrupt the motion of the vital organs.—The upper edge of the ribs is more obtuse and rounder than the lower, which is depressed on its internal side by a long *fossa*, for lodging the intercostal vessels and nerves; on each side of which there is a ridge, to which the intercostal muscles are fixed. The *fossa* is not observable however at either end of the ribs; for at the posterior or root, the vessels have not yet reached the ribs; and, at the fore-end, they are split away into branches, to serve the parts between the ribs: Which plainly teaches surgeons one reason of the greater safety of performing the operation of the *empyema* towards the sides of the *thorax*, than either near the back or the breast.

At the posterior end (*i*) of each *rib*, a little head is formed, which is divided by a middle ridge into two plain or hollow surfaces; the lowest of which is the broadest and deepest in most of them. The two planes are joined to the bodies of two different *vertebrae*, and the ridge forces itself into the intervening cartilage.—A little way from this head, we find, on the external surface, a small cavity, where mucilaginous glands are lodged; and round the head, the bone appears spongy, where the capsular ligament of the articulation is fixed.—Immediately beyond this a flatted tubercle rises, with a small cavity at, and roughness about its root, for the articulation of the rib with the transverse process of the lowest of the two *vertebrae*, with the bodies of which the head of the rib is joined.—Advancing farther on this external surface, we observe in most of the ribs another smaller tubercle, into which ligaments which connect the ribs

(i) Κωπιον, remulus.

ribs to each other, and to the tranſverſe proceſſes of the *vertebrae* and portions of the *longiſſimus dorſi*, are inſerted.—Beyond this the ribs are made flat by the *ſacro-lumbalis* muſcle, which is inſerted into the part of this flat ſurface fartheſt from the ſpine, where each rib makes a conſiderable curve, called by ſome its *angle*.—Then the rib begins to turn broad, and continues ſo to its anterior end, (*k*), which is hollow and ſpongy, for the reception of, and firm coalition with the cartilage that runs thence to be inſerted into the *ſternum*, or to be joined with ſome other cartilage.—In adults, generally the cavity at this end of the ribs is ſmooth and poliſhed on its ſurface; by which the articulation of the cartilage with it has the appearance of being deſigned for motion: but it has none.

The ſubſtance of the ribs is ſpongy, cellular, and only covered with a very thin external lamellated ſurface, which increaſes in thickneſs and ſtrength as it approaches the *vertebræ*.

To the fore-end of each rib, a long broad and ſtrong cartilage is fixed, and reaches thence to the *ſternum*, or is joined to the cartilage of the next rib. This courſe, however, is not in a ſtraight line with the rib; for, generally, the cartilages make a conſiderable curve, the concave part of which is upwards; therefore, at their inſertion into the *ſternum*, they make an obtuſe angle above, and an acute one below.—Theſe cartilages are of ſuch a length as never to allow the ribs to come to a right angle with the ſpine; but they keep them ſituated ſo obliquely, as to make an angle very conſiderably obtuſe above, till a force exceeding the elaſticity of the cartilages is applied.—Theſe cartilages, as all others, are firmer and harder internally, than they are on their external ſurface; and ſometimes in old people, all their middle ſubſtance becomes bony, while a thin cartilaginous *lamella* appears externally (*a*). The oſſification, however, begins frequently at the external ſurface.—The

(*k*) Πλατη, palmula.
(*a*) Veſal. lib. 2. cap. 19.

The greatest alternate motions of the cartilages being made at their great curvature, that part remains frequently cartilaginous, after all the rest is ossified (*b*).

The ribs then are articulated at each end, of which the one behind is doubly joined to the *vertebræ*; for the head is received into the cavities of two bodies of the *vertebræ*, and the larger tubercle is received into the depression in the transverse process of the lower *vertebra*.—When one examines the double articulation, he must immediately see, that no other motion can here be allowed than upwards and downwards; since the transverse process hinders the rib to be thrust back; the resistance on the other side of the *sternum* prevents the rib's coming forward; and each of the two joints, with the other parts attached, oppose its turning round. But then it is likewise as evident, that even the motion upwards and downwards can be but small in any one rib at the articulation itself. But as the ribs advance forwards, the distance from their centre of motion increasing, the motion must be larger; and it would be very conspicuous at their anterior ends, were not they resisted there by the cartilages, which yield so little, that the principal motion is performed by the middle part of the ribs, which turns outwards and upwards, and occasions the twist remarkable in the long ribs at the place near their fore-end where they are most resisted (*c*).

Hitherto I have laid down the structure and connection which most of the ribs enjoy, as belonging to all of them; but must now consider the specialities wherein any of them differ from the general description given, or from each other.

In viewing the ribs from above downwards, their figure is still straighter; the uppermost being the most crooked of any.—Their obliquity, in respect of the spine, increases as they descend; so that though their

(*b*) Havers Osteolog. nov. disc. 5. p. 289.
(*c*) Winslow Memoires de l'acad. des sciences, 1720.

heir diſtances from each other is very little different ıt their back-part, yet at their fore-ends the diſtances ›etween the lower ones muſt increaſe.—In conſe- ˌuence, too, of this increaſed obliquity of the lower ibs, each of their cartilages makes a greater curve in ts progreſs from the rib towards the *ſternum;* and he tubercles, that are articulated to the tranſverſe ›roceſſes of the *vertebræ*, have their ſmooth ſurfaces ˌradually facing more upwards.—The ribs becoming hus more oblique, while the *ſternum* advances for- vards in its deſcent, makes the diſtance between the *ernum* and the anterior end of the lower ribs greater han between the *ſternum* and the ribs above; con- ꞓquently the cartilages of thoſe ribs that are joined ɔ the breaſt-bone, are longer in the lower than in ıe higher ones.—Theſe cartilages are placed nearer ɔ each other as the ribs deſcend, which occaſions the urvature of the cartilages to be greater.

The length of the ribs increaſes from the firſt and ppermoſt rib, as far down as the ſeventh; and ·om that to the twelfth, as gradually diminiſhes.— 'he ſuperior of the two plain, or rather hollow ſur- ıces, by which the ribs are articulated to the bodies f the *vertebræ*, gradually increaſes from the firſt to ıe fourth rib, and is diminiſhed after that in each ›wer rib.—The diſtance of their angles from the eads always increaſes as they deſcend to the ninth, ecauſe of the greater breadth of the *ſacro-lumbalis* ıuſcle (*d*).

The ribs are commonly divided into *true* and *falſe*. The *true* (*e*) *coſtae* are the ſeven upper ones of each de, whoſe cartilages are all gradually longer as the bs deſcend, and are joined to the breaſt-bone; ſo ıat being preſſed conſtantly between two bones, ıey are flatted at both ends, and are thicker, harder, nd more liable to oſſify, than the other cartilages, ıat are not ſubject to ſo much preſſure. Theſe ribs include

(*d*) Winſlow Expoſition anatomique des os ſecs. § 641.

(*e*) Γνησαι, Germanæ, legitimæ.

include the heart and lungs; and therefore are the proper or true *custodes* of life.

The five inferior ribs of each side are the *false* or *BASTARD (f)*, whose cartilages do not reach to the *sternum;* and therefore, wanting the resistance at their fore-part, they are there pointed; and, on this account, having less pressure, their substance is softer.—The cartilages of these *false ribs* are shorter as the ribs descend.—To all these five ribs the circular edge of the *diaphragm* is connected; and its fibres, instead of being stretched immediately transversely, and so running perpendicular to the ribs, are pressed so as to be often, especially in exspiration, parallel to the plane in which the ribs lie: Nay, one may judge by the attachments which these fibres have so frequently to the sides of the *thorax*, a considerable way above where their extremities are inserted into the ribs, and by the situation of the *viscera*, always to be observed in a dead subject laid supine, that there is constantly a large concavity formed on each side by the *diaphragm* within these bastard ribs, in which the stomach, liver, spleen, &c. are contained; which, being only reckoned among the *viscera naturalia*, have occasioned the name of *bastard custodes* to these bones.

Hence, in simple fractures of the false ribs, without fever, the stomach ought to be kept moderately filled with food, lest the pendulous ribs falling inwards, should thereby increase the pain, cough, &c. (*g*).—Hence likewise we may learn how to judge better of the seat of several diseases, and to do the operation of the *empyema*, and some others, with more safety than we can do, if we follow the common directions.

The eight upper ribs were formerly (*h*) classed into pairs, with particular names to each two, to wit the

(*f*) Μαλθακαι, χονδροδεις, ακανθαι, κλενες, ροαι, adulterinæ, spuriæ illegitimæ.

(*g*) Hippocrat. de articulo, § 51.—Pare, lib. 15. cap. 11.

(*h*) Laurent. Hist. anat. lib. 2. cap. 29.—Paaw de ossibus, par. 3 cap. 2.

the *crooked*, the *solid*, the *pectoral*, the *twisted*: But these names are of so little use, that they are now generally neglected.

The *first* rib of each side is so situated, that the flat sides are above and below, while one edge is placed inwards, and the other outwards, or nearly so; therefore, sufficient space is left above it for the subclavian vessels and muscle; and the broad concave surface is opposed to the lungs: But then, in consequence of this situation, the channel for the intercostal vessels is not to be found, and the edges are differently formed from all the other, except the second; the lower one being rounded, and the other sharp.—The head of this rib is not divided into two plain surfaces by a middle ridge, because it is only articulated with the first *vertebra* of the *thorax*.—Its cartilage is ossified in adults, and is united to the *sternum* at right angles.—Frequently this first rib has a ridge rising near the middle of its posterior edge, where one of the heads of the *scalenus* muscle rises.—Farther forward it is flatted, or sometimes depressed by the clavicle.

The fifth, sixth, and seventh, or rather the sixth, seventh, eighth, and sometimes the fifth, sixth, seventh, eighth, ninth ribs, have their cartilages at least contiguous; and frequently they are joined to each other by cross cartilages; and most commonly the cartilages of the eighth, ninth, tenth, are connected to the former and to each other by firm ligaments.

The *eleventh*, and sometimes the *tenth* rib, has no tubercle for its articulation with the transverse process of the *vertebra*, to which it is only loosely fixed by ligaments.—The *fossa* in its lower edge is not so deep as in the upper ribs, because the vessels run more towards the interstice between the ribs.—Its fore-end is smaller than its body, and its short small cartilage is but loosely connected to the cartilage of the rib above.

The

The *twelfth* rib is the ſhorteſt and ſtraighteſt.—It head is only articulated with the laſt *vertebra* of th *thorax;* therefore is not divided into two ſurfaces.—This rib is not joined to the tranſverſe proceſs of th *vertebra*, and therefore has no tubercle, being ofte pulled neceſſarily inwards by the diaphragm, whic an articulation with the tranſverſe proceſs would no have allowed.—The *foſſa* is not found at its under edge, becauſe the veſſels run below it.—The fore part of this rib is ſmaller than its middle, and ha only a very ſmall pointed cartilage fixed to it.—T its whole internal ſide the diaphragm is connected.

The motions and uſes of the ribs ſhall be mor particularly treated of, after the deſcription of th *ſternum.*

The heads and tubercles of the ribs of a new born child have cartilages on them; part of whic becomes afterwards thin epiphyſes.—The bodies o the ribs encroach gradually after birth upon the cartilages; ſo that the latter are proportionally ſhorter when compared to the ribs, in adults, than in children.

Here I cannot help remarking the wiſe providenc of our Creator, in preſerving us from periſhing a ſoon as we come into the world. The end of th bones of the limbs remain in a cartilaginous ſtat after birth, and are many years before they are entirely united to the main body of their ſeveral bones; whereas, the condyles of the occipital bone, and o the lower jaw, are true original proceſſes, and oſſifie before birth, and the heads and tubercles of the rib are nearly in the ſame condition; and therefore, th weight of the large head is firmly ſupported; th actions of ſucking, ſwallowing, reſpiration, &c which are indiſpenſably neceſſary for us as ſoon a we come into the world, are performed withou danger of ſeparating the parts of the bones that ar moſt preſſed on in theſe motions: Whereas, ha theſe proceſſes of the head, jaw, and ribs, bee epiphyſes at birth, children muſt have been expoſe t

o danger of dying by ſuch a ſeparation; the imme-
liate conſequences of which would be, the compreſ-
ion of the beginning of the *ſpinal* marrow, or want
f food, or a ſtop put to reſpiration.

The *STERNUM* (i), or *breaſt-bone*, is the broad
at bone, or pile of bones, at the fore-part of the
horax.—The number of bones which this ſhould be
ivided into, has occaſioned debates among anato-
iſts, who have conſidered it in ſubjects of different
ges.—In adults of a middle age, it is compoſed of
hree bones, which eaſily ſeparate after the cartilages
onnecting them are deſtroyed. Frequently the two
wer bones are found intimately united; and very
ften in old people, the *ſternum* is a continued bony
ubſtance from one end to the other; though we ſtill
bſerve two, ſometimes three tranſverſe lines on its
rface; which are marks of the former diviſions.

When we conſider the *ſternum* as one bone, we
nd it broadeſt and thickeſt above, and becoming
naller as it deſcends. The internal ſurface of this
ne is ſomewhat hollowed for enlarging the *thorax*;
ut the convexity on the external ſurface is not ſo
nſpicuous, becauſe the ſides are preſſed outwards
the true ribs; the round heads of whoſe carti-
ges are received into ſeven ſmooth pits, formed in
ch ſide of the *ſternum*, and are kept firm there by
ong ligaments, which on the external ſurface have
particular radiated texture (k).—Frequently the
rtilaginous fibres thruſt themſelves into the bony
bſtance of the *ſternum*, and are joined by a ſort of
ture.—The pits at the upper part of the *ſternum*
e at the greateſt diſtance one from another, and, as
ey deſcend, are nearer; ſo that the two loweſt are
ntiguous.

The ſubſtance of the breaſt-bone is cellular, with
very thin external plate, eſpecially on its internal
face, where we may frequently obſerve a cartilagi-

 nous

(i) Στηθος, os pectoris, enſiforme, ſcutum cordis.

(k) Ruyſch. Catalog. rar. fig. 9.

nous cruſt ſpread over it (*l*). On both ſurfaces, how ever, a ſtrong ligamentous membrane is cloſely bra ced; and the cells of this bone are ſo ſmall, that conſiderable quantity of oſſeous fibres muſt be em ployed in the compoſition of it: Whence, with th defence which the muſcles give it, and the moveabl ſupport it has from the cartilages, it is ſufficiently ſe cured from being broken; for it is ſtrong by i quantity of bone; its parts are kept together by l gaments; and it yields enough to elude conſiderabl the violence offered (*m*).

So far may be ſaid of this bone in general; bu the three bones, of which, according to the commo account, it is compoſed in adults, are each to be exa mined.

The *firſt*, all agree, is ſomewhat of the figure of heart, as it is commonly painted; only it does no terminate in a ſharp point.—This is the uppermo thickeſt part of the *ſternum*.

The upper middle part of this firſt bone, where is thickeſt, is hollowed, to make place for the *trachi arteria;* though this cavity (*n*) is principally forme by the bone being raiſed on each ſide of it, partly b the clavicles thruſting it inwards, and partly by th *ſterno-maſtoidei* muſcles pulling it upwards.—On th outſide of each tubercle, there is an oblong cavit that, in viewing it tranſverſely from before back wards, appears a little convex: Into theſe *glenæ*, th ends of the clavicles are received.—Immediately be low theſe, the ſides of this bone begin to turn thin ner; and in each a ſuperficial cavity or a rough ſu face is to be ſeen, where the firſt ribs are received joined to the *ſternum*.—In the ſide of the under en of this firſt bone, the half of the pit for the ſecon rib on each ſide is formed.—The upper part of th ſurface behind is covered with a ſtrong ligamen whi

(*l*) Jac. Sylv. in Galen de oſſibus, cap. 12.
(*m*) Senac. in Memoires de l'acad. des ſciences, 1724.
(*n*) Σφαγη, jugulum, furcula ſuperior.

hich ſecures the clavicles; and is afterwards to be ıore particularly taken notice of.

The ſecond or middle diviſion of this bone, is ıuch longer, narrower, and thinner, than the firſt; ut, excepting that it is a little narrower above than ɛlow, it is nearly equal all over in its dimenſions of readth or thickneſs.—In the ſides of it are complete its for the third, fourth, fifth, and ſixth ribs, and ı half of the pits for the ſecond and ſeventh. The nes, which are marks of the former diviſion of this ɔne, being extended from the middle of the pits of ıe ſide to the middle of the correſponding pits of ıe other ſide.—Near its middle an unoſſified part of e bone is ſometimes found, which, freed of the ligaentous membrane or cartilage that fills it, is deribed as a hole; and in this place, for the moſt ırt, we may obſerve a tranſverſe line, which has ade authors divide this bone into two.—When e cartilage between this and the firſt bone is not ſified, a manifeſt motion of this upon the firſt may : obſerved in reſpiration, or in raiſing the *ſternum*, pulling the ribs upwards, or diſtending the lungs ith air in a recent ſubject.

The third bone is much leſs than the other two, ıd has only one half of the pit for the ſeventh rib rmed in it; wherefore it might be reckoned only ı *appendix* of the *ſternum*.—In young ſubjects it is ways cartilaginous, and is better known by the ıme of *cartilago xiphoides* or *enſiformis* (*o*), than any her; though the ancients often called the whole *rnum*, *enſiforme*, comparing the two firſt bones to e handle, and this *appendix* to the blade of a ſword.—his third bone is ſeldom of the ſame figure, magnide, or ſituation in any two ſubjects; for ſometimes is a plain triangular bone, with one of the angles ɛlow, and perpendicular to the middle of the upr ſide, by which it is connected to the ſecond bone.—

(*o*) Clypealis, gladialis, mucronata, malum granatum, ſcutum ſtochi, epiglottalis, cultralis, medium ſurculæ interioris, ſcutiformis, iculata.

In other people, the point is turned to one fide, o obliquely forwards or backwards.—Frequently it all nearly of an equal breadth, and in feveral fub jects it is bifurcated; whence fome writers give the name of *furcella* or *furcula inferior;* or elfe it unoffified, in the middle.—In the greateft number o adults it is offified; and tipped with a cartilage; i fome, one half of it is cartilaginous, and in other it is all in a cartilaginous ftate.—Generally, fever oblique ligaments fixed at one end to the cartilag of the ribs, and by the other to the outer furface o the *xiphoid* bone, connect it firmly to thofe cart lages (*p*).

So many different ways this fmall bone may b formed, without any inconvenience: But then fom of thefe pofitions may be fo directed, as to bring o a great train of ill confequences; particularly, whe the lower end is offified, and is too much turned out wards or inwards (*q*), or when the conjunction o this *appendix* with the fecond bone is too weak (*r*).

The *fternum* is joined by cartilages to the feve upper ribs, unlefs when the firft coalefces with it i an intimate union of fubftance: And its unequ cavity on each fide of its upper end is fitted for th ends of the clavicles.

The *fternum* moft frequently has four round fma bones, furrounded with cartilage, in children bor at the full time; the uppermoft of thefe, which the firft bone, being the largeft.—Two or three oth very fmall bony points are likewife to be feen in fe veral children.—The number of bones increafes fo fome years, and then diminifhes, but uncertainly, ti they are at laft united into thofe above defcribed of a adult.

Th

(*p*) Weitbrecht, Syndefmolog. p. 121.

(*q*) Rolfinc. Differt. anat. lib. 2. cap. 41.—Paaw de offib. pa 1. cap. 3. & par. 3. cap. 3.—Codronchi de prolapfu cartilagi mucronat.

(*r*) Paaw, ibid.—Borrich. act. Hafn. vol. 5. ob. 79.—Bonet. S pulchret. anat. tom. 2. lib. 3. § 5. Append. ad obf. 8. et. ibid. § obf. 19.

The uſes of this bone are, to afford origin and in-
ertion to ſeveral muſcles; to ſuſtain the *mediaſtinum*,
o defend the vital organs, the heart and lungs, at
he fore-part; and, laſtly, by ſerving as a moveable
ulcrum of the ribs, to aſſiſt conſiderably in reſpiration:
Vhich action, ſo far as it depends on the motion of
he bones, we are now at liberty to explain.

When the ribs that are connected by their cartilages
o the *ſternum*, or to the cartilages of the true ribs,
re acted upon by the intercoſtal muſcles, they muſt
ll be pulled from the oblique poſition which their
artilages kept them in, nearer to right angles with
he *vertebrae* and *ſternum*, becauſe the firſt or upper-
noſt rib is by much the moſt fixed of any; and the
artilages making a great reſiſtance to raiſing the an-
erior ends of the ribs, their large arched middle
arts turn outwards as well as upwards.—The *ſter-
um*, preſſed ſtrongly on both ſides by the cartilages
f the ribs, is puſhed forwards, and that at its ſeveral
arts, in proportion to the length and motion of its
upporters, the ribs; that is, moſt at its lower end.—
he *ſternum* and the cartilages, thus raiſed forwards,
nuſt draw the *diaphragm* connected to them; con-
equently ſo far ſtretch it, and bring it nearer to a
lane.—The power that raiſes this bone and the car-
lages, fixes them ſufficiently to make them reſiſt the
ction of the *diaphragm*, whoſe fibres contract at the
me time, and thruſt the *viſcera* of the *abdomen*
ownwards.—The arched part of the ribs being thus
noved outwards, their anterior ends and the *ſternum*
eing advanced forwards, and the diaphragm being
rought nearer to a plain ſurface, inſtead of being
reatly convex on each ſide within each cavity of the
orax, it is evident how conſiderably the cavity, of
hich the nine or ten upper ribs are the ſides, muſt
e widened, and made deeper and longer.—While
his is doing in the upper ribs, the lower ones, whoſe
artilages are not joined to the *ſternum* or to other
artilages, move very differently, though they con-
ire to the ſame intention, the enlargement of the

thorax: For having no fixed point to which their anterior ends are faſtened, and the *diaphragm* being inſerted into them at the place where it runs pretty ſtraight upwards from its origin at the *vertebræ*, theſe ribs are drawn downwards by this ſtrong muſcle, and by the muſcles of the *abdomen*, which, at this time, are reſiſting the ſtretching force of the bowels; while the intercoſtal muſcles are pulling them in the contrary direction, to wit, upwards: The effect therefore of either of theſe powers, which are antagoniſts to each other, is very little, as to moving the ribs either up or down; but the muſcles of the *abdomen*, puſhed at this time outwards by the *viſcera*, carry theſe ribs along with them.—Thus the *thorax* is not only not allowed to be ſhortened, but is really widened at its lower part, to aſſiſt in making ſufficient ſpace for the due diſtenſion of the lungs.

As ſoon as the action of theſe ſeveral muſcles ceaſes, the elaſtic cartilages, extending themſelves to their natural ſituation, depreſs the upper ribs, and the *ſternum* ſubſides;—the diaphragm is thruſt up by the *viſcera abdominalia*, and the oblique and tranſverſe muſcles of the belly ſerve to draw the inferior ribs inwards at the ſame time.—By theſe cauſes, the cavity of the breaſt is diminiſhed in all its dimenſions.

Though the motions above deſcribed of the ribs and *ſternum*, eſpecially of the latter bone, are ſo ſmall in the mild reſpiration of a healthy perſon, that we can ſcarce obſerve them; yet they are manifeſt whenever we deſignedly increaſe our reſpiration, or are obliged to do it after exerciſe, and in ſeveral diſeaſes.

OF THE SUPERIOR EXTREMITIES.

AUthors are much divided in their opinions about the number of bones which each *ſuperior extremity* (*a*) ſhould be ſaid to conſiſt of, ſome deſcribing the

(*a*) Κωλα, γυα, ἐκφυαδες, Enata, adnata, explantata membra, artus.

ie *clavicle* and *ſcapula* as part of it, others claſſing ieſe two bones with thoſe of the *thorax*: But ſince ioſt quadrupeds have no *clavicles*, and the human *orax* can perform its functions right when the *ſcapula* taken away (*b*), whereas it is impoſſible for us to ave the right uſe of our arms without theſe bones; muſt think that they belong to the *ſuperior extremi-es*; and therefore ſhall divide each of them into the *oulder*, *arm*, *fore-arm*, and *hand*.

The *SHOULDER* conſiſts of the *clavicle* and *ſca-ula*.

CLAVICULA, or *collar-bone* (*c*), is the long crook-l bone, in figure like an *Italic ſ*, placed almoſt hori-ontally between the upper lateral part of the *ſternum*, nd what is commonly called the top of the ſhoulder, hich, as a *clavis* or beam, it bears off from the trunk f the body.

The *clavicle*, as well as other long round bones, is rger at its two ends, than in the middle. The end ext to the *ſternum* (*d*) is triangular: The angle be-ind is conſiderably produced, to form a ſharp ridge, which the tranſverſe ligament, extended from one avicle to the other, is fixed (*e*).—The ſide oppoſite this is ſomewhat rounded.—The middle of this otuberant end is as irregularly hollowed, as the ca-ty in the *ſternum* for receiving it is raiſed; but in recent ſubject, the irregular concavities of both are ipplied by a moveable cartilage, which is not only iuch more cloſely connected every where by liga-ents to the circumference of the articulation, than ioſe of the lower jaw are; but it grows to the two ɔnes at both its internal and external end; its ibſtance at the internal end being ſoft, but very ſtrong, id reſembling the intervertebral cartilages (*f*).

From

(*b*) Philoſoph. tranſact. numb. 449. § 5.

(*c*) Os jugulare, jugulum, furcula, ligula, clavis, humerus qui-iſdam.

(*d*) Παρασφαγις.

(*e*) Riolan. Encheirid. anat. lib. 6. cap. 13.—Winſlow, expoſ. iat. des os frais, § 248.—Weitbrecht, Act. Petropolit. tom. 4. p. 5. et Syndeſmolog. ſect. 2. I. § 3.

(*f*) Weitbrecht, Syndeſmolog. ſect. 2. I. ſect 6.

From this internal end, the *clavicle*, for about two fifths of its length, is bended obliquely forwards and downwards. On the upper and fore-part of this curvature a ſmall ridge is ſeen, with a plain rough ſurface before it; whence the *muſculus ſterno-hyoideus* and *ſterno-maſtoideus* have in part their origin.—Near the lower angle a ſmall plain ſurface is often to be remarked, where the firſt rib and this bone are contiguous (*g*), and are connected by a firm ligament (*h*).—From this a rough plain ſurface is extended outwards, where the pectoral muſcle has part of its origin.—Behind, the bone is made flat and rough by the inſertion of the larger ſhare of the ſubclavian muſcle.—After the clavicle begins to be bended backwards, it is round, but ſoon after becomes broad and thin; which ſhape it retains to its external end.—Along the external concavity, a rough ſinuoſity runs, from which ſome part of the deltoid muſcle takes its riſe:—Oppoſite to this, on the convex edge, a ſcabrous ridge gives inſertion to a ſhare of the *cucullaris* muſcle. The upper ſurface of the clavicle here is flat; but the lower is hollow, for lodging the beginning of the *muſculus ſubclavius*; and towards its back-part a tubercle riſes, to which, and a roughneſs near it, the ſtrong ſhort thick ligament connecting this bone to the *coracoid* proceſs of the *ſcapula* is fixed.

The external end (*i*) of this bone is horizontally oblong, ſmooth, ſloping at the poſterior ſide, and tipped in a recent ſubject with a cartilage, for its articulation with the *acromion ſcapulæ*.—Round this the bone is ſpongy, for the firmer connection of the ligaments.

The medullary arteries, having their direction obliquely outwards, enter the clavicles by one or more ſmall paſſages in the middle of their back-part.

The ſubſtance of this bone is the ſame as of the other round long bones.

The

(*g*) Dionis, Sixieme demonſt. des os.
(*h*) Weitbrecht, Syndeſmolog. ſect. 2. I. § 7.
(*i*) Επωμις.

The triangular unequal interior end of each *clavicle*, has the cartilage above defcribed interpofed betwixt it and the irregular cavity of the *fternum*.—The ligaments, which furround this articulation to fecure it, are fo fhort and ftrong, that little motion can be allowed any way; and the ftrong ligament that is ftretched acrofs the upper *furcula* of the *fternum*, from the pofterior prominent angle of the one clavicle, to the fame place of the other clavicle, ferves to keep each of thefe bones more firmly in their place.—By the affiftance, however, of the moveable intervening cartilage, the clavicle can, at this joint, be raifed or depreffed, and moved backwards and forwards fo much, as that the external end, which is at a great diftance from that axis, enjoys very confpicuous motions.—The articulation of the exterior end of the clavicle fhall be confidered after the defcription of the *fcapula*.

The clavicles of infants are not deficient in any of their parts; nor have they any epiphyfes at their extremities joined afterwards to their bodies, as moft other fuch long bones have, which preferves them from being bended too much, and from the danger of any unoffified parts being feparated by the force which pulls the arms forwards.

The ufes of the clavicles are, to keep the *fcapulae*, and confequently all the *fuperior extremities*, from falling in and forward upon the *thorax*; by which, as in moft quadrupeds, the motions of the arms would be much confined, and the breaft made too narrow.—The clavicles likewife afford origin to feveral mufcles, and a defence to large veffels.

From the fituation, figure, and ufe of the clavicles, it is evident, that they are much expofed to fractures; that their broken parts muft generally go by each other; and that they are difficultly kept in their place afterwards.

SCAPULA, or *fhoulder-blade* (*b*), is the triangular bone

(*b*) Ωμοπλατος, επινωτιον, latitudo humeri, fceptulum vel fcutulum opertum, fpatula, ala, humerus, clypeus, fcutum thoracis.

bone ſituated on the outſide of the ribs, with its longeſt ſide called its *baſe*, towards the ſpinal proceſſes of the *vertebrae*, and with the angle at the upper part of this ſide about three inches, and the lower angle at a greater diſtance from theſe proceſſes.—The back-part of the *ſcapula* has nothing but the thin ends of the *ſerratus anticus major* and *ſubſcapularis* muſcles between it and the ribs: But as this bone advances forwards, its diſtance from the ribs increaſes.—The upper or ſhorteſt ſide, called the *ſuperior coſta* of the *ſcapula* is nearly horizontal, and parallel with the ſecond rib.—The lower ſide, which is named the *inferior coſta*, is extended obliquely from the third to the eighth rib.—The ſituation of this bone here deſcribed, is when people are ſitting or ſtanding in a ſtate of inactivity, and allowing the members to remain in the moſt natural eaſy poſture.—The inferior angle of the *ſcapula* is very acute; the upper one is near to a right angle; and what is called the anterior, does not deſerve the name, for the two ſides do not meet to form an angle.—The body of this bone is concave towards the ribs, and convex behind, where it has the name of *dorſum* (*c*).—Three proceſſes are generally reckoned to proceed from the *ſcapula*.—The firſt is the large ſpine that riſes from its convex ſurface behind, and divides it unequally.—The ſecond proceſs ſtands out from the fore-part of the upper ſide; and, from its imaginary reſemblance to a crow's beak, is named *coracoides* (*d*).—The third proceſs is the whole thick bulbous fore-part of the bone.

After thus naming the ſeveral conſtituent parts of the *ſcapula*, the particular deſcription will be more eaſily underſtood.

The *baſe*, which is tipped with cartilage in a young ſubject, is not all ſtraight: For above the ſpine, it runs obliquely forwards to the ſuperior angle; that here it might not be too protuberant backwards, and ſo bruiſe the muſcles and teguments: Into the oblique

(*c*) Χελιτιον.
(*d*) Anchoroides, ſigmoides, digitalis, anciſtroides.

lique ſpace the *muſculus patientiæ* is inſerted.—At the root of the ſpine, on the back-part of the baſe, a triangular plain ſurface is formed, by the preſſure of the lower fibres of the *trapezius*.—Below this the edge of the *ſcapula* is ſcabrous and rough, for the inſertion of the *ſerratus major anticus* and *rhomboid* muſcles.

The back-part of the inferior angle is made ſmooth by the *latiſſimus dorſi* paſſing over it. This muſcle alſo alters the direction of the *inferior coſta* ſome way forwards from this angle: and ſo far it is flatted behind by the origin of the *teres major*.—As the *inferior coſta* advances forward, it is of conſiderable thickneſs, is ſlightly hollowed and made ſmooth behind by the *teres minor*, while it has a *foſſa* formed into it below by part of the *ſubſcapularis*; and between the two a ridge with a ſmall depreſſion appears, where the *longus extenſor cubiti* has its origin.

The *ſuperior coſta* is very thin; and near its forepart there is a ſemilunar niche, from one end of which to the other a ligament is ſtretched; and ſometimes the bone is continued, to form one, or ſometimes two holes for the paſſage of the ſcapular blood-veſſels and nerves.—Immediately behind this *ſemilunar* cavity the *coraco-hyoid* muſcle has its riſe.—From the niche to the termination of the *foſſa* for the *teres minor*, the *ſcapula* is narrower than any where elſe, and ſupports the third proceſs. This part has the name of *cervix*.

The whole *dorſum* of the *ſcapula* is always ſaid to be convex; but, by reaſon of the raiſed edges that ſurround it, it is divided into two cavities by the ſpine, which is ſtretched from behind forwards, much nearer to the ſuperior than to the inferior *coſta*.—The cavity above the ſpine is really concave where the *ſupra-ſpinatus* muſcle is lodged; while the ſurface of this bone below the ſpine, on which the *infra-ſpinatus* muſcle is placed, is convex, except a *foſſa* that runs at the ſide of the *inferior coſta*.

The internal or anterior ſurface of this bone is hollow, except in the part above the ſpine, which is

convex.—

convex.—The *ſubſcapularis* muſcle is extended ove this ſurface, where it forms ſeveral ridges and inte mediate depreſſions, commonly miſtaken for print of the ribs; they point out the interſtices of the bun dles of fibres of which the *ſubſcapularis* muſcle is com poſed (*e*).

The ſpine *(f)* riſes ſmall at the baſe of the *ſcapul* and becomes higher and broader as it advances for wards.—On the ſides it is unequally hollowed an crooked, by the actions of the adjacent muſcles.—It ridge (*g*) is divided into two rough flat ſurfaces: In to the upper one, the *trapezius* muſcle is inſerted and the lower one has part of the *deltoid* fixed to it.— The end of the ſpine, called *acromion* (*h*), or top o the ſhoulder, is broad and flat, and is ſometimes on ly joined to the ſpine by a cartilage (*i*).—The anterio edge of the *acromion* is flat, ſmooth, and covere with a cartilage, for its articulation with the externa end of the clavicle; and it is hollowed below, to allo a paſſage to the *infra* and *ſupra ſpinati* muſcles, an free motion to the *os humeri*.

The *coracoid* (*k*) proceſs is crooked, with its poin inclining forwards; ſo that a hollow is left at th lower ſide of its root, for the paſſage of the *infra-ſca-pularis* muſcle.—The end of this proceſs is marked wit three plain ſurfaces. Into the internal, the *ſerratu minor anticus* is inſerted: From the external, one hea of the *biceps flexor cubiti* riſes; and from the lowe one, the *coraco-brachialis* has its origin.—At the up-per part of the root of this proceſs, immediately be-fore the *ſemilunar* cavity, a ſmooth tubercle appears, where a ligament from the *clavicle* is fixed. From all the external ſide of this coracoid *apophyſe*, a broad ligament goes out, which becomes narrower where it

(*e*) Winſlow, in Memoires de l'acad. des ſciences, 1722.

(f) Ραχις, ὑπεροχη ωμοπλατων, eminentia ſcapularum.

(*g*) Pterigium, criſta.

(*h*) Επωμις αγκυροειδης, κορακοειδης, κατακλεις, acromii os, ſummus armus, roſtrum porcinum, proceſſus digitalis.

(*i*) Sue Trad. d'Oſteol. p. 160.

(*k*) Ἀγκυροειδης, σιγμοειδης, roſtriformis.

is fixed to the *acromion*.—The ſharp pain, vio-
ent inflammation, and tedious cure of contuſions in
is part, are probably owing to theſe tendons and
gaments being hurt.

From the *cervix ſcapulæ* the third proceſs is produ-
d. The fore-part of this is formed into a *glenoid* ca-
ty (*l*), which is of the ſhape of the longitudinal ſec-
on of an egg, being broad below, and narrow a-
ve.—Between the brims of this hollow and the
re-part of the root of the ſpine, a large ſinuoſity is
ft for the tranſmiſſion of the *ſupra* and *infra-ſpinati*
uſcles; and on the upper-part of theſe brims we
ay remark a ſmooth ſurface, where the ſecond head
the *biceps flexor cubiti* has its origin.—The root of
e *ſupercilia* is rough all round, for the firmer adhe-
n of the capſular ligament of the articulation, and
the cartilage which is placed on theſe brims, where
is thick, but becomes very thin as it is continued
wards the middle of the cavity, which it lines all
er.

The medullary veſſels enter the *ſcapula* near the
e of the ſpine.

The ſubſtance of the *ſcapula*, as in all other broad
bones, is cellular, but of an unequal thickneſs;
the neck and third proceſs are thick and ſtrong.
e inferior *coſta*, ſpine, and coracoid proceſs, are
a middle thickneſs; and the body is ſo preſſed by
muſcles, as to become thin and diaphanous.

The *ſcapula* and clavicle are joined by plain ſur-
es, tipped with cartilage (*m*): by which neither
e is allowed any conſiderable motion, being tight-
ied down by the common capſular ligament, and
a very ſtrong one which proceeds from the cora-
d proceſs; but divides into two before it is fixed
the *clavicle*, with ſuch a direction, as either can
w this bone to have a ſmall rotation, in which its
terior edge turns more backwards, while the an-
or one riſes farther forwards; or it can yield to
Q the

) Ωμοκοτυλις.
) Acromion, κατακλεις, clauſuræ.

the fore-part of the *ſcapula* moving downwards, while the back-part of it is drawn upwards; in both which caſes, the oblong ſmooth articulated ſurfaces of the *clavicle* and *ſcapula* are not in the ſame plane, but ſtand a little tranſverſely, or acroſs each other, and thereby preſerve this joint from luxations, to which it would be ſubject, if either of the bones was to move on the other perpendicularly up and down, without any rotation.——Sometimes a moveable ligamentous cartilage is found in this joint; otherwhiles, ſuch a cartilage is only interpoſed at the anterior half of it; and in ſome old ſubjects I have found a ſeſamoid bone here (*n*).—The *ſcapula* is connected to the head, *os hyoides*, *vertebræ*, ribs, and arm-bone, by muſcles that have one end faſtened to theſe bones, and the other to the *ſcapula*, which can move it upwards, downwards, backwards, or forwards; by the quick ſucceſſion of theſe motions, its whole body is carried in a circle. But being alſo often moved as upon an axis perpendicular to its plane, its circumference turns in a circle whoſe centre this axis is (*o*). Whichever of theſe motions it performs, it always carries the outer end of the clavicle and the arm along with it.—The *glenoid* cavity of this bone receives the *os humeri* which plays in it as a ball in a ſocket, as will be explained more hereafter.

The uſe of the *ſcapula* is, to ſerve as a *fulcrum* to the arm; and, by altering its poſition on different occaſions, to allow always the head of the *os humeri* a right ſituated ſocket to move in; and thereby to aſſiſt and to enlarge greatly the motions of the *ſuperior extremity*, and to afford the muſcles which riſe from it more advantageous actions, by altering their directions to the bone which they are to move.——This bone alſo ſerves to defend the back-part of the *thorax*, and is often employed to ſuſtain weights, or to reſiſt forces, too great for the arm to bear.

Th

(*n*) Jac. Sylv. Iſagog. anat. lib. 1. cap. 2.
(*o*) See Winſlow Memoires de l'acad. des ſciences, 1726.

The baſe, *acromion*, coracoid proceſs, and head of the *ſcapula*, are all in a cartilaginous ſtate at birth; and the three firſt are joined as *epiphyſes*; while the head, with the *glenoid* cavity, is not formed into a diſtinct ſeparate bone, but is gradually produced by the oſſification of the body of this bone being continued forwards.

The *ARM* has only one bone, beſt known by the *Latin* name of *os humeri* (*p*); which is long, round, and nearly ſtraight.

The upper end of this bone (*q*) is formed into a large round ſmooth head, whoſe middle point is not in a ſtraight line with the axis of the bone, but ſtands obliquely backwards from it.——The extent of the head is diſtinguiſhed by a circular *foſſa* ſurrounding its baſe, where the head is united to the bone, and the capſular ligament of the joint is fixed.——Below the fore-part of its baſe two tubercles ſtand out: The ſmalleſt one, which is ſituated moſt to the inſide, has the tendon of the *ſubſcapularis* muſcle inſerted into it.—The larger more external protuberance is divided, at its upper part, into three ſmooth plain ſurfaces; into the anterior of which the *muſculus ſupra-ſpinatus*; into the middle or largeſt, the *infra-ſpinatus*; into the one behind, the *teres minor* is inſerted.—Between theſe two tubercles, exactly in the fore-part of the bone, a deep long *foſſa* is formed, for lodging the tendinous head of the *biceps flexor cubiti*; which, after paſſing, in a manner peculiar to itſelf, through the cavity of the articulation, is tied down by a tendinous ſheath extended acroſs the *foſſa*; in which, and in the neighbouring tubercles, are ſeveral remarkable holes, which are penetrated by the tendinous and ligamentous fibres, and by veſſels.—On each ſide of this *foſſa*, as it deſcends in the *os humeri*, a rough ridge, gently flatted in the middle, runs from the roots of the tubercles.—The tendon of the *pectoral*

 muſcle

(*p*) Ακρωλια, αλενη, os brachii, armi, adjutorium, parvum brachium, canna brachii.

(*q*) Acrocolium.

mufcle is fixed into the anterior of thefe ridges, and the *latiffimus dorfi*, and *teres major*, are inferted into the internal one.—A little behind the lower end of this laft, another rough ridge may be obferved, where the *coraco-brachialis* is inferted.—From the back-part of the root of the largeft tubercle a ridge alfo is continued, from which the *brevis extenfor cubiti* rifes.—This bone is flatted on the infide, about its middle, by the belly of the *biceps flexor cubiti*.—In the middle of this plain furface, the entry of the medullary artery is feen flanting obliquely downwards.—At the forefide of this plane the bone rifes in a fort of ridge, which is rough, and often has a great many fmall holes in it, where the tendon of the ftrong *deltoid* mufcle is inferted; on each fide of which the bone is fmooth and flat, where the *brachiœus internus* rifes. The exterior of thefe two flat furfaces is the largeft; behind it a fuperficial fpiral channel, formed by the *mufcular* nerve, and the veffels that accompany it, runs from behind forwards and downwards.—The body of the *os humeri* is flatted behind by the extenfors of the fore-arm.—Near the lower end of this bone, a large fharp ridge is extended on its outfide, from which the *mufculus fpinator radii longus*, and the longeft head of the *extenfor carpi radialis* rife.—Oppofite to this, there is another fmall ridge to which the *aponeurotic* tendon, that gives origin to the fibres of the internal and external *brachiœi* mufcles is fixed; and from a little depreffion on the fore-fide of it, the *pronator radii teres* rifes.

The body of the *os humeri* becomes gradually broader towards the lower end, where it has feveral proceffes; at the roots of which there is a cavity before, and another behind (*r*). The anterior is divided by a ridge into two; the external, which is the leaft, receives the end of the *radius;* and the internal receives the *coronoid* procefs of the *ulna* in the flections of the fore-arm, while the pofterior deep triangular cavity lodges the *olecranon* in the extenfions of that member.

(*r*) βαθμιδεις.

nember.——The bone betwixt theſe two cavities is preſſed ſo thin by the proceſſes of the *ulna*, as to appear diaphanous in ſeveral ſubjects —The ſides of the poſterior cavity are ſtretched out into two proceſſes, one on each ſide: Theſe are called *condyles;* from each of which a ſtrong ligament goes out to the bones of the *fore-arm.*—The external *condyle*, which has an oblique direction alſo forwards in reſpect of the internal, when the arm is in the moſt natural poſture (*s*), is equally broad, and has an obtuſe ſmooth head riſing from it forwards.——From the rough part of the *condyle*, the inferior head of the *bicornis*, the *extenſor digitorum communis*, *extenſor carpi ulnaris*, *anconæus*, and ſome part of the *ſupinator radii brevis* take their riſe; and on the ſmooth head the upper end of the *radius* plays.—Immediately on the outſide of this, there is a ſinuoſity made by the ſhorter head of the *bicornis* muſcle, upon which the *muſcular* nerve is placed.——The internal *condyle* is more pointed and protuberant than the external, to give origin to ſome part of the *flexor carpi radialis*, *pronator radii teres*, *palmaris longus*, *flexor digitorum ſublimis*, and *flexor carpi ulnaris*. Between the two *condyles*, is the *trochlea* or pully, which conſiſts of two lateral protuberances, and a middle cavity, that are ſmooth and covered with cartilage.—When the fore-arm is extended, the tendon of the internal *brachiæus* muſcle is lodged in the fore-part of the cavity of this pully.—The external protuberance, which is leſs than the other, has a ſharp edge behind; but forwards, this edge is obtuſe, and only ſeparated from the little head, already deſcribed, by a ſmall *foſſa*, in which the joined edges of the *ulna* and *radius* move.—The internal protuberance of the pully is largeſt and higheſt; and therefore in the motions of the *ulna* upon it, that bone would be inclined outwards, was it not ſupported by the *radius* on that ſide.—Between this internal protuberance and *condyle*,

(*s*) Winſlow Memoires de l'acad. des ſciences, 1722.

a ſinuoſity may be remarked, where the *ulnar* nerve paſſes.

The ſubſtance and the internal ſtructure of the *os humeri* is the ſame, and diſpoſed in the ſame way, as in other long bones.

The round head at the upper end of this bone is articulated with the *glenoid* cavity of the *ſcapula*; which being ſuperficial, and having long ligaments, allows the arm a free and extenſive motion.—Theſe ligaments are however conſiderably ſtrong. For, beſides the common capſular one, the tendons of the muſcles perform the office, and have been deſcribed under the name of *ligaments*.——Then the *acromion* and *coracoid* proceſs, with the ſtrong broad ligaments ſtretched betwixt them, ſecure the articulation above, where the greateſt and moſt frequent force is applied to thruſt the head of the bone out of its place. It is true that there is not near ſo ſtrong a defence at the lower part of the articulation; but in the ordinary poſtures of the arm, that is, ſo long as it is at an acute angle with the trunk of the body, there cannot be any force applied at this place to occaſion a luxation, ſince the joint is protected ſo well above.

The motions which the arm enjoys by this articulation, are to every ſide; and by the ſucceſſion of theſe different motions, a circle may be deſcribed.—Beſides which, the bone performs a ſmall rotation round its own *axis*. But though this can be performed with the round head in all poſitions; yet as theſe vary, the effects upon the body of the bone are very different: For, if the middle of the head is the centre of rotation, as it is when the arm hangs down by the ſide, the body of the bone is only moved forwards and backwards; becauſe the *axis* of motion of the head is nearly at right angles with the length of the bone (*t*); whereas, when the arm is raiſed to right angles with the trunk of the body, the centre of motion, and the axis of the bone, come to be in the ſame ſtraight line; and therefore the body of the

os

(*t*) Hippocrat. de articul. § 1.

os humeri performs the ſame motion with its head.—Though the motions of the arm ſeem to be very extenſive, yet the larger ſhare of them depends on the motion of the *ſcapula.*—The lower end of the *os humeri* is articulated with the bones of the fore-arm, and carries them with it in all its motions, but ſerves as a baſe on which they perform the motions peculiar to themſelves; as ſhall be deſcribed afterwards.

Both the ends of this bone are cartilaginous in a new-born infant, and the large head with the two tubercles, and the *trochlea* with the two *condyles*, become *epiphyſes* before they are united to the body of the bone.

The *FORE-ARM* (*u*) conſiſts of two long bones, the *ulna* and *radius;* whoſe ſituation, in reſpect of each other, is oblique in the leaſt ſtraining or moſt natural poſture; that is, the *ulna* is not directly behind, nor on the outſide of the *radius*, but in a middle ſituation between theſe two, and the *radius* croſſes it.—The ſituation however of theſe two bones, and of all the other bones of the *ſuperior extremity* that are not yet deſcribed, is frequently altered; and therefore, to ſhun repetitions, I deſire it may be now remarked, that, in the remaining account of the *ſuperior extremity*, I underſtand by the term of *poſterior*, that part which is in the ſame direction with the back of the hand; by *anterior*, that anſwering to the palm; by *internal*, that on the ſame ſide with the thumb; by *external*, the ſide neareſt to the little finger; ſuppoſing the hand always to be in a middle poſition between *pronation* and *ſupination.*

ULNA (*a*), ſo named from its being uſed as a meaſure, is the longeſt of the two bones of the fore-arm, and ſituated on the outſide of the *radius.*

At the upper end of the *ulna* are two proceſſes.—The poſterior is the largeſt, and formed like a hook, whoſe concave ſurface moves upon the pully of the *os*

(*u*) Cubitus, πηχυς, ωλενη, πυγων, ulna, lacertus.

(*a*) Cubitus, πηχυς, προπηχυον, focile majus, canna vel arundo major, et inferior brachii.

os humeri, and is called *olecranon* (*b*), or top of the cubit.—The convex back-part of it is rough and ſcabrous, where the *longus*, *brevis*, and *brachiœus externus*, are inſerted. The *olecranon* makes it unneceſſary that the tendons of the extenſor muſcles ſhould paſs over the end of the *os humeri*; which would have been of ill conſequence in the great flections of this joint, or when any conſiderable external force is applied to this part (*c*).—The anterior proceſs is not ſo large, nor does it reach ſo high as the one behind; but is ſharper at its end, and therefore is named *coronoid*.—Between theſe two proceſſes, a large ſemicircular or *ſigmoid* concavity is left; the ſurface of which, on each ſide of a middle riſing, is ſlanting, and exactly adapted to the pully of the bone of the arm.—Acroſs the middle of it, there is a ſmall ſinuoſity for lodging mucilaginous glands; where, as well as in a ſmall hollow on the internal ſide of it, the cartilage that lines the reſt of its ſurface is wanting.—Round the brims of this concavity the bone is rough, where the capſular ligament of the joint is implanted.—Immediately below the *olecranon*, on the back-part of the *ulna*, a flat triangular ſpongy ſurface appears, on which we commonly lean.—At the internal ſide of this, there is a larger hollow ſurface, where the *muſculus anconœus* is lodged; and the ridge at the inſide of this gives riſe to the *muſculus ſupinator radii brevis*.—Between the top of the ridge and the *coronoid* proceſs is the ſemilunated ſmooth cavity, lined with cartilage, in which, and a ligament extended from the one to the other end of this cavity, the round head of the *radius* plays.—Immediately below it a rough hollow gives lodging to mucilaginous glands.—Below the root of the *coronoid* proceſs, this bone is ſcabrous and unequal, where the *brachiœus internus* is inſerted.—On the outſide of that we obſerve a ſmooth concavity, where the beginning of the *flexor digitorum profundus* ſprouts out.

The

(*b*) Αγκων, gibber cubitus, additamentum necatum.

(*c*) Winſlow Expoſition anatomique du corps humain, traité des os ſecs, ſect. 979.

The body of the *ulna* is triangular.—The internal ngle is very ſharp where the ligament that connects he two bones is fixed:—The ſides, which make this ngle, are flat and rough, by the action and adheſion f the many muſcles which are ſituated here.—At he diſtance of one third of the length of the *ulna* rom the top, in its fore-part, the paſſage of the me-ullary veſſels is to be remarked ſlanting upwards.—'he external ſide of this bone is ſmooth, ſomewhat onvex, and the angles at each edge of it are blunted y the preſſure of the muſcles equally diſpoſed about iem.

As this bone deſcends, it becomes gradually ſmal-r; ſo that its lower end terminates in a little head, anding on a ſmall neck.—Towards the fore but outer art of which laſt, an oblique ridge runs, that gives ſe to the *pronator radii quadratus*.—The head is ound, ſmooth, and covered with a cartilage on its ternal ſide, to be received into the ſemilunar cavity f the *radius*; while a *ſtyloid* proceſs (*d*) riſes from its utſide, to which is fixed a ſtrong ligament that is tended to the *os cuneiforme* and *piſiforme* of the wriſt. -Between the back-part of that internal ſmooth ſide id this proceſs, a ſinuoſity is left for the tendon of e *extenſor carpi ulnaris*.—On the fore-part of the ot of the proceſs, ſuch another depreſſion may be marked for the paſſage of the *ulnar* artery and nerve. -The end of the bone is ſmooth, and covered with cartilage.—Between it and the bones of the wriſt, doubly concave moveable cartilage is interpoſed; hich is a continuation of the cartilage that covers e lower end of the *radius*, and is connected looſely the root of the *ſtyloid* proceſs, and to the rough vity there; in which mucilaginous glands are dged.

The *ulna* is articulated above with the lower end of e *os humeri*, where theſe bones have depreſſions and otuberances correſponding to each other, ſo as to ow an eaſy and ſecure extenſion of the fore-arm to almoſt

(*d*) Γραφειδης, malleolus externus.

almoſt a ſtraight line with the arm, and flection to very acute angle; but, by the ſlanting poſition of th pully, the lower part of the fore-arm is turned outwards in the extenſion, and inwards in the flection (*e*); and a very ſmall kind of rotation is likewiſe allowed in all poſitions, eſpecially when the ligaments are moſt relaxed by the fore-arm being in middle degree of flection.—The *ulna* is alſo articulated with the *radius* and *carpus*, in a manner to be related afterwards.

RADIUS (*f*), ſo called from its imagined reſemblance to a ſpoke of a wheel, or to a weaver's beam is the bone placed at the inſide of the fore-arm. Its upper end is formed into a circular little head, which is hollowed for an articulation with the tubercle at the ſide of the pully of the *os humeri*; and the half of the round circumference of the head next to the *ulna* is ſmooth, and covered with a cartilage, in order to be received into the ſemilunated cavity of that bone.—Below the head, the *radius* is much ſmaller therefore this part is named its *cervix*, which is made round by the action of the *ſupinator radii brevis*.—At the external root of this neck, a tuberous proceſs riſes; into the outer part of which the *biceps flexor cubiti* is inſerted.—From this a ridge runs downwards and inwards, where the *ſupinator radii brevis* is inſerted; and a little below, and behind this ridge there is a rough ſcabrous ſurface, where the *pronator radii teres* is fixed.

The body of the *radius* is not ſtraight, but convex on its internal and poſterior ſurfaces; where it is alſo made round by the equal preſſure of the circumjacent muſcles, particularly of the *extenſors* of the thumb; but the ſurfaces next to the *ulna* are flatted and rough, for the origin of the muſcles of the hand; and both terminate in a common ſharp ſpine, to which the ſtrong ligament extended betwixt the two bones of the fore-arm is fixed.—A little below the beginning of

(*e*) Winſlow, Memoires de l'acad. des ſciences, 1722.

(*f*) Κερκίς, παρακηχιον, focile minus, canna minor, arundo minor.

the plain ſurface, on its fore-part, where the *flexor* uſcle of the laſt joint of the thumb takes its origin, e paſſage of the medullary veſſels is ſeen ſlanting wards.—The *radius* becomes broader and flatter to- ards the lower end, eſpecially on its fore-part, where *pronator quadratus* muſcle is ſituated.

The lower end of the *radius* is larger than the ſu- rior; though not in ſuch a diſproportion as the up- r end of the *ulna* is larger than its lower end.—Its ck-part has a flat ſtrong ridge in the middle, and *ſſæ* on each ſide.—In a ſmall groove immediately on e outſide of the ridge, the tendon of the *extenſor tii internodii pollicis* plays.—In a large one beyond is, the tendons of the *indicator* and of the common *tenſor* muſcles of the fingers paſs.—Contiguous to e *ulna*, there is a ſmall depreſſion made by the *ex- nſor minimi digiti*.—On the inſide of the ridge there a broad depreſſion, which ſeems again ſubdivided, here the two tendons of the *bicornis*, or *extenſor car- radialis*, are lodged.—The internal ſide of this end the *radius* is alſo hollowed by the extenſors of the ſt and ſecond joint of the thumb; immediately a- ve which, a little rough ſurface ſhews where the *pinator radii longus* is inſerted.—The ridges at the les of the grooves, in which the tendons play, have annular ligament fixed to them, by which the ſe- ral ſheaths for the tendons are formed.—The fore- rt of this end of the *radius* is alſo depreſſed, where e flexors of the fingers and *flexor carpi radialis* paſs. The external ſide is formed into a ſemilunated ooth cavity, lined with a cartilage, for receiving e lower end of the *ulna*.—The loweſt part of the *dius* is formed into an oblong cavity; in the middle which is a ſmall tranſverſe riſing, gently hollowed, r lodging mucilaginous glands; while the riſing it- f is inſinuated into the conjunction of the two nes of the wriſt that are received into the cavity. The internal ſide of this articulation is fenced by remarkable proceſs (*g*) of the *radius*, from which a ligament

(*g*) Malleolus internus, proceſſus ſtyloides.

ligament goes out to the wriſt, as the *ſtyloid* proceſs of the *ulna* with its ligament guards it on the outſide.

The ends of both the bones of the fore-arm being thicker than the middle, there is a conſiderable diſtance between the bodies of theſe bones; in the larger part of which a ſtrong tendinous, but thin ligament, is extended, to give a large enough ſurface for the origin of the numerous fibres of the muſcles ſituated here, that are ſo much ſunk between the bones, as to be protected from injuries, which they would otherwiſe be expoſed to. But this ligament is wanting near the upper end of the fore-arm, where the *ſupinator radii brevis*, and *flexor digitorum profundus*, are immediately connected (*h*).

Both ends of the bones of the fore-arm are firſt cartilages, and then *epiphyſes* in children.

As the head of the *radius* receives the tubercle of the *os humeri*, it is not only bended and extended along with the *ulna*, but may be moved round its *axis* in any poſition; and that this motion round its *axis* may be ſufficiently large, the ligament of the articulation is extended farther down than ordinary on the neck of this bone, before it is connected to it; and it is very thin at its upper and lower part, but makes a firm ring in the middle.—This bone is alſo joined to the *ulna* by a double articulation; for above, a tubercle of the *radius* plays in a ſocket of the *ulna;* whilſt below, the *radius* gives the ſocket, and the *ulna* the tubercle: But then the motion performed in theſe two is very different; for at the upper end, the *radius* does no more than turn round its axis; while at the lower end, it moves in a ſort of *cycloid* upon the round part of the *ulna*; and as the hand is articulated and firmly connected here with the *radius*, they muſt move together.—When the palm is turned uppermoſt, the *radius* is ſaid to perform the *ſupination;* when the back of the hand is above, it is ſaid to be *prone*. But then the quickneſs and large extent of theſe

(*h*) Weitbrecht, Syndeſmolog. fig. 10, 11.

hese two motions are aſſiſted by the *ulna*, which, as ras before obſerved, can move with a kind of ſmall otation on the ſloping ſides of the pulley. This laeral motion, though very inconſiderable in the joint ſelf, is conſpicuous at the lower end of ſuch a long one; and the ſtrong ligament connecting this lower nd to the *carpus*, makes the hand more readily to bey theſe motions.—When we deſign a large circur turn of our hand, we increaſe it by the rotation f the *os humeri*, and ſometimes employ the ſpine and *ferior extremities* to make theſe motions of pronation r ſupination of the hand large enough.

The *HAND* (*i*) comprehends all from the joint of e wriſt to the points of the fingers. Its back-part convex, for greater firmneſs and ſtrength; and it concave before, for containing more ſurely and conеniently ſuch bodies as we take hold of.—One half f the hand has an obſcure motion in compariſon of hat the other has, and ſerves as a baſe to the moveble half; which can be extended back very little farer than to a ſtraight line with the fore-arm, but can e conſiderably bended forwards.

As the bones that compoſe the hand are of diffent ſhapes and uſes, while ſeveral of them that are ntiguous agree in ſome general characters; the nd is, on this account, commonly divided into the *rpus*, *metacarpus*, and *fingers*; among which laſt e thumb is reckoned.

The *CARPUS* (*k*) is compoſed of eight ſmall ſpon- bones, ſituated at the upper part of the hand. I all deſcribe each of theſe bones, under a proper me taken from their figure (*l*); becauſe the method ranging them by numbers leaves anatomiſts too uch at liberty to debate very idly, which ought to preferred to the firſt number; or, which is worſe, veral, without explaining the order they obſerve, fferently apply the ſame numbers, and ſo confound eir readers.—But that the deſcription of theſe bones

R may

(*i*) Ἀκροχειρ, ſumma manus.
(*k*) Κτεις, brachiale, prima palmæ pars, raſetta.
(*l*) Lyſer. Cult. anat. lib. 5. cap. 2.

may be in the ſame order as they are found in the generality of anatomical books, I ſhall begin with the range of bones that are concerned in the moveable joint of the wriſt, or are connected to the fore-arm, and ſhall afterwards conſider the four that ſupport the thumb and *oſſa metacarpi* of the fingers.

The eight bones of the *carpus* are, *os ſcaphoides, lunare, cuneiforme, piſiforme, trapezium, trapezoides, magnum, unciforme.*

The *ſcaphoides* is ſituated moſt internally of thoſe that are articulated with the fore-arm.—The *lunare* is immediately on the outſide of the former.—The *cuneiforme* is placed ſtill more externally, but does not reach ſo high up as the other two.—The *piſiforme* ſtands forwards into the palm from the *cuneiforme*.—The *trapezium* is the firſt of the ſecond row, and is ſituated betwixt the *ſcaphoides* and firſt joint of the thumb.—The *trapezoides* is immediately on the outſide of the *trapezium*.—The *os magnum* is ſtill more external.—The *unciforme* is farther to the ſide of the little finger.

Os ſcaphoides (*m*) is the largeſt of the eight except one. It is convex above, concave and oblong below; from which ſmall reſemblance of a boat it has got its name.—Its ſmooth convex ſurface is divided by a rough middle *foſſa*, which runs obliquely croſs it.—The upper largeſt diviſion is articulated with the *radius*.—Into the *foſſa* the common ligament of the joint of the wriſt is fixed; and the lower diviſion is joined to the *trapezium* and *trapezoides*.—The concavity receives more than an half of the round head of the *os magnum*.—The external ſide of this hollow is formed into a ſemilunar plane, to be articulated with the following bone.—The internal, poſterior, and anterior edges are rough, for fixing the ligaments that connect it to the ſurrounding bones.

Os lunare (*n*) has a ſmooth convex upper ſurface by which it is articulated with the *radius*.—The inter-

na

(*m*) Κοτυλοειδης, naviculare.
(*n*) Lunatum.

al ſide, which gives the name to the bone, is in the ɔrm of a creſcent, and is joined with the *ſcaphoid*;—ıe lower ſurface is hollow, for receiving part of the ead of the *os magnum*.—On the outſide of this cavi-ɣ is another ſmooth, but narrow oblong ſinuoſity, ɔr receiving the upper end of the *os unciforme*:—)n the outſide of which a ſmall round convexity is ɔund, for its connection with the *os cuneiforme*.—etween the great convexity above, and the firſt deep ıferior cavity, there is a rough *foſſa*, in which the ırcular ligament of the joint of the wriſt is fixed.

Os cuneiforme (*p*) is broader above, and towards the ack of the hand, than it is below and forwards; hich gives it the reſemblance of a wedge.—The ſu-erior ſlightly convex ſurface is included in the joint f the wriſt, being oppoſed to the lower end of the *'na*.—Below this the cuneiform bone has a rough *ſſa*, wherein the ligament of the articulation of the riſt is fixed.—On the internal ſide of this bone, here it is contiguous to the *os lunare*, it is ſmooth and ightly concave.—Its lower ſurface, where it is con-guous to the *os unciforme* is oblong, ſomewhat ſpiral, ıd concave.—Near the middle of its anterior ſurface circular plane appears, where the *os piſiforme* is ſuſ-ined.

Os piſiforme (*q*) is almoſt ſpherical, except one cir-ılar plane, or ſlightly hollow ſurface, which is co-ered with cartilage for its motion on the cuneiform ɔne, from which its whole rough body is prominent ɔrwards into the palm; having the tendon of the *xor carpi ulnaris*, and a ligament from the *ſtyloid* ocefs of the *ulna*, fixed to its upper part; the *tranſ-rſe* ligament of the wriſt is connected to its inter-ıl ſide; ligaments extended to the *unciform* bone, ıd to the *os metacarpi* of the little finger, are attach-l to its lower part; the *abductor minimi digiti* has its igin from its fore-part; and, at the internal ſide of it,

R 2

(*p*) Triquetrum.

(*q*) Cartilaginoſum, ſubrotundum, rectum.

it, a ſmall depreſſion is formed, for the paſſage of the ulnar nerve.

Trapezium (*r*) has four unequal ſides and angles in its back-part, from which it has got its name.—Above, its ſurface is ſmooth, ſlightly hollowed, and ſemicircular, for its conjunction with the *os ſcaphoides.* —Its external ſide is an oblong concave ſquare, for receiving the following bone.—The inferior ſurface is formed into a pulley; the two protuberant ſides of which are external and internal. On this pulley the firſt bone of the thumb is moved.—At the external ſide of the external protuberance, a ſmall oblong ſmooth ſurface is formed by the *os metacarpi indicis.*—The fore-part of the *trapezium* is prominent in the palm, and, near to the external ſide, has a ſinuoſity in it, where the tendon of the *flexor carpi radialis* is lodged; on the ligamentous ſheath of which the tendon of the *flexor tertii internodii pollicis* plays: And ſtill more externally the bone is ſcabrous, where the *tranſverſe* ligament of the wriſt is connected, the *abductor* and *flexor primi internodii pollicis* have their origin, and ligaments go out to the firſt bone of the thumb.

Os trapezoides (*s*), ſo called from the irregular quadrangular figure of its back-part, is the ſmalleſt bone of the wriſt except the *piſiforme.*—The figure of it is an irregular cube.—It has a ſmall hollow ſurface above, by which it joins the *ſcaphoides*; a long convex one internally, where it is contiguous to the *trapezium*; a ſmall external one, for its conjunction with the *os magnum*; and an inferior convex ſurface, the edges of which are however ſo raiſed before and behind, that a ſort of pulley is formed, where it ſuſtains the *os metacarpi indicis.*

Os magnum (*t*), ſo called becauſe it is the largeſt bone of the *carpus*, is oblong, having four quadrangular ſides, with a round upper end, and a triangular plain

(*r*) Os cubiforme, trapezoides, multangulum majus.
(*s*) Trapezium, multangulum minus.
(*t*) Maximum, capitatum.

lain one below.——The round head is divided by a nall riſing, oppoſite to the connection of the *os aphoides* and *lunare*, which together form the cavity or receiving it.—On the inſide a ſhort plain ſurface ins the *os magnum* to the *trapezoides*.—On the out-de is a long narrow concave ſurface, where it is ontiguous to the *os unciforme*.—The lower end, which ıſtains the metacarpal bone of the middle finger, is iangular, ſlightly hollowed, and farther advanced n the internal ſide than on the external, having a onſiderable oblong depreſſion made on the advanced ıſide by the metacarpal bone of the fore-finger; and enerally there is a ſmall mark of the *os metacarpi di-iti annularis* on its external ſide.

Os unciforme (*u*) has got its name from a thin broad rocefs that ſtands out from it forwards into the palm, ıd is hollow on its inſide, for affording paſſage to ıe tendons of the flexors of the fingers. To this rocefs alſo the tranſverſe ligament is fixed, that binds own and defends theſe tendons; and the *flexor* and *ductor* muſcles of the little finger have part of their igin from it.——The upper plain ſurface is ſmall, onvex, and joined with the *os lunare*:—The internal de is long, and ſlightly convex, adapted to the con-guous *os magnum*:—The external ſurface is oblique, ıd irregularly convex, to be articulated with the cu-eiform bone:—The lower end is divided into two oncave ſurfaces; the external is joined with the me-carpal bone of the little finger, and the internal ıe is fitted to the metacarpal bone of the ring-ıger.

In the deſcription of the preceding eight bones, I ıve only mentioned thoſe plain ſurfaces covered with rtilage, by which they are articulated to each other, to ſome other bones, except in ſome few caſes, here ſomething extraordinary was to be obſerved; ıd I have deſignedly omitted the other rough ſur-ces, leſt, by crowding too many words in the de-ription of ſuch ſmall bones, the whole ſhould be

 unintelligible:

(*u*) Cuneiforme.

unintelligible: But these scabrous parts of the bones may easily be understood, after mentioning their figure, if it is observed, that they are generally found only towards the back or palm of the hand; that they are all plain, larger behind than before; and that they receive the different ligaments, by which they are either connected to neighbouring bones, or to one another; for these ligaments cover all the bones, and are so accurately applied to them, that, at first view, the whole *carpus* of a recent subject appears one smooth bone (*x*).

As the surfaces of these bones are largest behind, the figure of the whole conjoined must be convex there, and concave before; which concavity is still more increased by the *os pisiforme*, and process of the *os unciforme*, standing forwards on one side, as the *trapezium* does on the other: And the bones are securely kept in this form, by the broad strong transverse ligament connected to these parts of them that stand prominent into the palm of the hand.—The convexity behind renders the whole fabric stronger, where it is most exposed to injuries; and the large anterior hollow is necessary for a safe passage to the numerous vessels, nerves, and tendons of the fingers.

The substance of these bones is spongy and cellular, but strong in respect of their bulk.

The three first bones of the *carpus* make an oblong head, by which they are articulated with the cavity at the lower ends of the bones of the fore-arm; so as to allow motion to all sides, and, by a quick succession of these motions, they may be moved in a circle. But as the joint is oblong, and therefore the two dimensions are unequal, no motion is allowed to the *carpus* round its axis, except what it has in the pronation and supination along with the *radius*.—— The articulation of the first three bones of the superior row, with the bones of the inferior, is such as allows of motion, especially backwards and forwards; to

(*x*) Galen de usu part. lib. 2. cap. 8. For a particular description of these ligaments, see Weitbrecht Syndesmolog. p. 5.—68.

n the ſecurity and eaſineſs of which the reception of he *os magnum* into the cavity formed by the *ſcaphoides* nd *lunare* contributes conſiderably: And the greateſt umber of the muſcles that ſerve for the motion of he wriſt on the *radius*, being inſerted beyond the onjunction of the firſt row of bones with the ſecond, ct equally on this articulation as they do on the forner; but the joint formed with the *radius* being the noſt eaſily moved, the firſt effect of theſe muſcles is n it; and the ſecond row of the *carpus* is only moved afterwards. By this means a larger motion of the riſt is allowed, than otherwiſe it could have had fely: For, if as large motion had been given to one int, the angle of flection would have been very cute, and the ligaments muſt have been longer than as conſiſtent with the firmneſs and ſecurity of the int.—The other articulations of the bones here beg by nearly plain ſurfaces, ſcarce allow of any ore motion, becauſe of the ſtrong connecting ligaents, than to yield a little, and ſo elude the force any external power; and to render the back of the riſt a little more flat, or the palm more hollow, on oper occaſions. The articulations of the thumb nd metacarpal bones ſhall be examined afterwards.

The uſes of the *carpus* are to ſerve as a baſe to the nd, to protect its tendons, and to afford it a free rge motion.

All the bones of the *carpus* are in a cartilaginous ate at the time of birth.

On account of the many tendons that paſs upon e lower end of the fore-arm and the *carpus*, and the numerous ligaments of theſe tendons and of e bones, which have lubricating liquors ſupplied to em, the pain of ſprains here is acute, the parts ke long time to recover their tone, and their ſwellgs are very obſtinate.

METACARPUS (*x*) conſiſts of four bones which ſtain the fingers.—Each bone is long and round, with

(*x*) Κτεις, προκαρπιον, στηθος, ανδηρον, κτενιον, poſtbrachiale, pec-, palma, pecten.

with its ends larger than its body.—The upper end, which ſome call the baſe, is flat and oblong, without any conſiderable head or cavity; but it is however ſomewhat hollowed, for the articulation with the *carpus:* It is made flat and ſmooth on the ſides where theſe bones are contiguous to each other.—Their bodies are flatted on their back-part by the tendons of the extenſors of the fingers.—The anterior ſurface of theſe bodies is a little concave, eſpecially in their middle; along which a ſharp ridge ſtands out, which ſeparates the *muſculi interoſſei* placed on each ſide of theſe bones which are there made flat and plain by theſe muſcles.

Their lower ends are raiſed into large oblong ſmooth heads, whoſe greateſt extent is forwards from the axis of the bone.—At the fore-part of each ſide of the root of each of theſe heads, one or two tubercles ſtand out, for fixing the ligaments that go from one metacarpal bone to another, to preſerve them from being drawn aſunder.—Round the heads a rough ring may be remarked, for the capſular ligaments of the firſt joints of the fingers to be fixed to; and both ſides of theſe heads are flat, by preſſing on each other.

The ſubſtance of the metacarpal bones is the ſame with that of all long bones.

At the time of birth, theſe bones are cartilaginous at both ends, which afterwards become *epiphyſes*.

The metacarpal bones are joined above to the *oſſa carpi* and to each other by nearly plain ſurfaces. Theſe connections are not fit for large motions.—The articulation of their round heads at the lower ends with the cavities of the firſt bones of the fingers, is to be taken notice of hereafter.

The concavity on the fore-part of theſe metacarpal bones, and the placing their baſes on the arched *carpus*, cauſe them to form a hollow in the palm of the hand, which is uſeful often to us.—The ſpaces between them lodge muſcles, and their ſmall motion makes them fit ſupporters for the fingers to play on.

Though

Though the *offa metacarpi* fo far agree, yet they ıay be diftinguifhed from each other by the followıg marks.

The *os metacarpi indicis* is generally the longeft.—s bafe, which is articulated with the *os trapezoides*, hollow in the middle.—The fmall ridge on the in-ːrnal fide of this oblong cavity is fmaller than the ıe oppofite to it, and is made flat on the fide by the *apezium*.—The exterior ridge is alfo fmooth, and ıt on its outfide, for its conjunction with the *os agnum*; immediately below which, a femicircular nooth flat furface fhews the articulation of this to ıe fecond metacarpal bone.—The back-part of this ıfe is flatted, where the long head of the *extenfor rpi radialis* is inferted; and its fore-part is promi-ːnt, where the tendon of the *flexor carpi radialis* is xed.—The external fide of the body of this bone is ıore hollowed by the action of mufcles, than the ıternal.—The tubercle at the internal root of its ːad is larger than the external.—Its bafe is fo firm- fixed to the bone it is connected with, that it has o motion.

Os metacarpi medii digiti is generally the fecond in ngth; but often it is as long as the former; fome-mes it is longer; and frequently it appears only to ıual the firft by the *os magnum* being farther ad-ınced downwards than any other bone of the rift.—Its bafe is a broad fuperficial cavity, flanting utwards; the internal pofterior angle of which is prominent, as to have the appearance of a pro-ːfs.—The internal fide of this bafe is made plain ı the fame way as the external fide of the former one, while its external fide has two hollow circular ırfaces, for joining the third metacarpal bone; and etween thefe furfaces there is a rough *foffa*, for the dhefion of a ligament, and lodging mucilaginous lands.—The fhorter head of the *bicornis* is inferted ıto the back-part of this bafe.—The two fides of ıis bone are almoft equally flatted; only the ridge ı the fore-part of the body inclines outwards.—

The

The tubercles at the fore-part of the root of the head are equal.—The motion of this bone is very little more than the firſt metacarpal one has; and therefore, theſe two firmly reſiſt bodies preſſed againſt them by the thumb, or fingers, or both.

Os metacarpi digiti annularis is ſhorter than the ſecond metacarpal bone.—Its baſe is ſemicircular and convex, for its conjunction with the *os unciforme*.—On its internal ſide are two ſmooth covexities, and a middle *foſſa*, adapted to the ſecond metacarpal bone.—The external ſide has a triangular ſmooth concave ſurface to join it with the fourth one.—The anterior ridge of its body is ſituated more to the out than to the inſide.—The tubercles near the head are equal.—The motion of this third metacarpal bone is greater than the motion of the ſecond.

Os metacarpi minimi digiti is the ſmalleſt and ſharpeſt.—Its baſe is irregularly convex, and riſes ſlanting outwards.—Its internal ſide is exactly adapted to the third metacarpal bone.—The external has no ſmooth ſurface, becauſe it is not contiguous to any other bone; but it is prominent where the *extenſor carpi ulnaris* is inſerted.—As this *metacarpal* bone is furniſhed with a proper moving muſcle, has the plaineſt articulation, is moſt looſely connected and leaſt confined, it not only enjoys a much larger motion than any of the reſt, but draws the third bone with it, when the palm of the hand is to be made hollow by its advancement forwards, and by the prominence of the thumb oppoſite to it.

The *THUMB* and four *FINGERS* are each compoſed of three long bones.

The *Thumb* (y) is ſituated obliquely in reſpect of the fingers, neither oppoſite directly to them, nor in the ſame plane with them.—All its bones are much thicker and ſtronger in proportion to their length, than the bones of the fingers are: Which was extremely neceſſary, ſince the thumb counteracts all the fingers.

The

(y) Ἀντίχειρ, δικόνδυλος, magnus-digitus, promanus.

The firſt bone of the thumb has its baſe adapted ɔ the double pulley of the *trapezium:* For, in view- ıg it from one ſide to the other, it appears convex ı the middle; but when conſidered from behind ɔrwards, it is concave there.—The edge at the fore- art of this baſe is produced farther than any other art; and round the back-part of the baſe a rough *foſſa* ıay be ſeen, for the connection of the ligaments of ıis joint.—The body and head of this bone are of ıe ſame ſhape as the *oſſa metacarpi;* only that the ody is ſhorter, and the head flatter, with the tu- ercles at the fore-part of its root larger.

The articulation of the upper end of this bone is ncommon: For, though it has protuberances and epreſſions adapted to the double pulley of the *tra- zium;* yet it enjoys a circular motion, as the joints ɔ where a round head of one bone plays in the or- cular ſocket of another; only it is ſomewhat more ɔnfined and leſs expeditious, but ſtronger and more cure, than ſuch joints generally are.

This bone of children is in the ſame ſtate with the etacarpal bones.

The ſecond bone of the thumb has a large baſe rmed into an oblong cavity, whoſe greateſt length from one ſide to the other.—Round it ſeveral tu- ercles may be remarked, for the inſertion of liga- ents.—Its body is convex, or a half round behind; ıt flat before, for lodging the tendon of the long exor of the thumb, which is tied down by liga- entous ſheaths that are fixed on each ſide to the an- e at the edge of this flat ſurface.—The lower end this ſecond bone has two lateral round protube- nces, and a middle cavity, whoſe greateſt extent of ıooth ſurface is forwards.

The articulation and motion of the upper end of is ſecond bone is as ſingular as that of the former.— ɔr its cavity being joined to the round head of the ſt bone, it would ſeem at firſt view to enjoy mo- ɔn in all directions; yet, becauſe of the ſtrength its lateral ligaments, oblong figure of the joint it- ſelf,

ſelf, and mobility of the firſt joint, it only allows flection and extenſion; and theſe are generally much confined.

The third bone of the thumb is the ſmalleſt, with a large baſe, whoſe greateſt extent is from one ſide to the other.—This baſe is formed into two cavities and a middle protuberance, to be adapted to the pulley of the former bone.—Its body is rounded behind; but is flatter than in the former bone, for ſuſtaining the nail.—It is flat and rough before, by the inſertion of the *flexor tertii internodii.*—This bone becomes gradually ſmaller, till near the lower end where it is a little enlarged, and has an oval ſcabrous edge.

The motion of this third bone is confined to flection and extenſion.

The orderly diſpoſition of the bones of the *finger* into three rows, has made them generally obtain the name of three *phalanges* (z).—All of them have hal round convex ſurfaces, covered with an *aponeuroſis* formed by the tendons of the *extenſors*, *lumbricales* and *interoſſei*, and placed directly backwards, for thei greater ſtrength; and their flat concave part is forwards, for taking hold more ſurely, and for lodging the tendons of the flexor muſcles.—The ligament for keeping down theſe tendons are fixed to th angles that are between the convex and concave ſides

The bones of the firſt *phalanx* (*a*) of the finger anſwer to the deſcription of the ſecond bone of th thumb: Only that the cavity in their baſe is not ſ oblong; nor is their motion on the metacarpal bone ſo much confined: For they can be moved laterall or circularly, but have no rotation, or a very ſmall degree of it, round their axis.

Both the ends of this firſt *phalanx* are in a cartilaginous ſtate at the birth; and the upper one is afterwards affixed in form of an *epiphyſe.*

Th

(z) Scytalidæ, internodia, ſcuticula, agmina, acies, condyli articu

(a) Προκονδυλοι.

The second bone (*b*) of the fingers has its base ormed into two lateral cavities, and a middle protuerance; while the lower end has two lateral protuerances and a middle cavity; therefore, it is joined t both ends in the same manner, which none of the ones of the thumb are.

This bone is in the same condition with the former 1 children.

The third bone (*c*) differs nothing from the deription of the third bone of the thumb, excepting 1 the general distinguishing marks; and therefore, ie second and third *phalanx* of the fingers enjoy onflection and extension.

The upper end of this third *phalanx* is a cartilage a ripe child; and is only an *epiphyse* after, till the ll growth of the body.

All the difference of the *phalanges* of the several ıgers consists in their magnitude.—The bones of the *iddle finger* (*a*) being the longest and largest,—those the *fore-finger* (*b*) come next to that in thickness, ıt not in length, for those of the *ring-finger* (*c*) are little longer. The *little finger* (*d*) has the smallest nes. Which disposition is the best contrivance for lding the largest bodies; because the longest fingers e applied to the middle largest periphery of such bstances as are of a spherical figure (*e*).

The uses of all the parts of our *superior extremities* e so evident in the common actions of life, that it needless to enumerate them here; and therefore I all proceed to the last part of the skeleton. Only, lt I should seem to have forgot the small bones at e joints of the hand, I desire now to refer to the cription of them, under the common title of *sesa-*

S *moid*

(*b*) Κονδυλοι.

(*c*) Μετακονδυλοι, ριζωνυχια.

(*a*) Καταπυγων, οφακκελος, infamis, impudicus, verpus, famosus, ocenus.

(*b*) Δεκτικος, indicator, λιχανος, demonstrativus, salutaris.

(*c*) Ἰατρικος, παραμεσος, δακτυλιωτης, επιβατης, annularis, medis, cordis digitus.

(*d*) Μυωψ, ωτιτης, auricularis, minimus.

(*e*) Galen de usu part. lib. 1. cap. 24.

moid bones, which I have placed after the bones of the feet.

OF THE INFERIOR EXTREMITIES.

THE *INFERIOR EXTREMITIES* depend from the *acetabula* of the *oſſa innominata*; are commonly divided into three parts, viz. the thigh, leg, and foot.

The *THIGH* (*f*) has only one bone; which is the longeſt of the body, and the largeſt and ſtrongeſt of any of the cylindrical bones. The ſituation of it is not perpendicular; for the lower end is inclined conſiderably inwards; ſo that the knees are almoſt contiguous, while there is a conſiderable diſtance between the thigh-bones above; which is of good uſe to us, ſince ſufficient ſpace is thereby left for the external parts of generation, the two great *cloacæ* of urine and *fœces*, and for the large thick muſcles that move the thigh inwards; and at the ſame time this ſituation of the thigh-bones renders our progreſſion quicker, ſurer, ſtraighter, and in leſs room; for, had the knees been at a greater diſtance from each other we muſt have been obliged to deſcribe ſome part of a circle with the trunk of our body in making a long ſtep, and, when one leg was raiſed from the ground, our centre of gravity would have been too far from the baſe of the other, and we ſhould conſequently have been in hazard of falling; ſo that our ſteps would neither have been ſtraight nor firm; nor would it have been poſſible to walk in a narrow path, had our thigh-bones been otherwiſe placed. In conſequence, however, of the weight of the body bearing ſo obliquely on the joint of the knee, by this ſituation of the thigh-bones, weak ricketty children become in-knee'd.

The upper end of the thigh-bone is not continued in a ſtraight line with the body of it, but is ſet on oblique

(*f*) Μηρον, femen, coxa, agis, anchæ os, crus, femur.

bliquely inwards and upwards, whereby the diſtance ere between theſe two bones at their upper part is onſiderably increaſed.—This end is formed into a rge ſmooth round head (*g*), which is the greater por-on of a ſphere unequally divided.—Towards its ower internal part a round rough ſpongy pit is ob-rvable, where the ſtrong ligament, commonly, but njuſtly, called the *round* one, is fixed, to be extend-l from thence to the lower internal part of the re-eiving cavity, where it is conſiderably broader than ear to the head of the thigh-bone.—The ſmall part elow the head, called the *cervix* of the *os femoris*, as a great many large holes into which the fibres of e ſtrong ligament, continued from the capſular, nter, and are thereby ſurely united to it; and round e root of the neck, where it riſes from the bone, a ough ridge is found, where the capſular ligament of e articulation itſelf is connected.—Below the back-art of this root, the large unequal protuberance call-d *trochanter major* (*h*), ſtands out; the external con-ex part of which is diſtinguiſhed into three different irfaces, whereof the one on the fore-part is ſcabrous nd rough, for the inſertion of the *glutæus minimus*; e ſuperior one is ſmooth, and has the *glutæus medius* nſerted into it; and the one behind is made flat and nooth by the tendon of the *glutæus maximus* paſſing ver it.—The upper edge of this proceſs is ſharp and ointed at its back-part, where the *glutæus medius* is xed; but forwards it is more obtuſe, and has two iperficial pits formed in it: Into the ſuperior of heſe, the *pyriformis* is implanted; and the *obturator nternus* and *gemini* are fixed into the lower one.—rom the backmoſt prominent part of this great *tro-hanter*, a rough ridge runs backwards and down-vards, into which the *quadratus* is inſerted.—In the eep hollow, at the internal upper ſide of this ridge, e *obturator externus* is implanted.—More internally, conoid proceſs called *trochanter minor* (*i*), riſes for

S 2 the

(*g*) Vertebrum.
(*h*) Γλουτος, rotator natis, malum granatum teſticulorum.
(*i*) Rotator minor.

the insertion of the *musculus psoas* and *iliacus internus*; and the *pectineus* is implanted into a rough hollow below its internal root.—The muscles inserted into these two processes being the principal instruments of the rotatory motion of the thigh, have occasioned the name of *trochanters* to the processes.—The tendons that are fixed into, or pass over the great *trochanter*, cause bruises by falls on this part to be attended with great pain and weakness of the limb, which generally remain long.

The body of the *os femoris* is convex on the fore-part, and made hollow behind, by the action of the muscles that move it and the leg, and for the conveniency of sitting, without bearing too much on these muscles; and probably the weight of the legs depending from the thighs in that posture, contributes to this curvature.—The fore-part of the thigh-bone is a little flatted above by the beginning of the *cruræus* muscle, as it is also below by the same muscle and the *rectus*.—Its external surface is likewise made flat below by the *vastus externus*, where it is separated from the former by an obtuse ridge.—The *vastus internus* depresses a little the lower part of the internal surface.—The posterior concave surface has a ridge rising in its middle commonly called *linea aspera*, into which the *triceps* is inserted, and the short head of the *biceps flexor tibiæ* rises from it.—At the upper part of it the medullary vessels enter by a small hole that runs obliquely upwards; a little above which there is a rough *fossa* or two, where the tendon of the *glutæus maximus* is fixed.—The lower end of the *linea aspera* divides into two, which descend towards each side.—The two *vasti* muscles have part of their origin from these ridges; and the long tendon of the *triceps* is fixed to the internal, by means of part of the *fascia aponeurotica* of the thigh.—Near the beginning of the internal ridge, there is a discontinuation of the ridge where the crural artery passes through the *aponeurosis*.—Between these two rough lines, the bone is made flat by the large blood-vessels and nerves which pass upon

pon it; and near the end of each of these ridges, a nall smooth protuberance may often be remarked, here the two heads of the external *gastrocnemius* iuscle take their rise, and where sesamoid bones are metimes found (*k*); and from the fore-part of the ternal tubercle, a strong ligament is extended to the side of the *tibia*.

The lower end of the *os femoris* is larger than any her part of it, and is formed into a great protuberice on each side, called its *condyles*; between which considerable cavity is found, especially at the backirt, in which the crural vessels and nerves lie imersed in fat.—The internal condyle is longer than e external, which must happen from the oblique sition of this bone, to give less obliquity to the g.—Each of these processes seems to be divided in plain smooth surface. The mark of division on e external is a notch, and on the internal a small otuberance. The fore-part of this division, on hich the *rotula* moves, is formed like a pulley, the ternal side of which is highest.—Behind, there e two oblong large heads, whose greatest extent is ckwards, for the motion of the *tibia*; and from e rough cavity between them, but near to the base the internal condyle, the strong ligament comonly called the *cross* one, has its rise;—a little alve which a rough protuberance gives insertion to e tendon of the *triceps*.—The condyles, both on the ter and inner side of the knee, are made flat by the iscles passing along them.—On the back-part of the ernal, a slight depression is made by the tendons the *gracilis* and *sartorius*; and on the external such other is formed by the *biceps flexor cruris*; behind hich a deep *fossa* is to be observed, where the *poplitus* muscle has its origin.—From the tubercle imdiately before this cavity, a strong round ligament es out to the upper part of the *fibula*.—Round this wer end of the thigh-bone, large holes are found, o which the ligaments for the security of the joint

(*k*) Vesal. lib. 1. cap. 28. & 30.

are fixed, and blood-veſſels paſs to the internal ſubſtance of the bone.

All the proceſſes of the *femur* are cartilaginous in new-born children, and afterwards become ſmall *apophyſes*, with large *epiphyſes*.

The thigh-bone being articulated above with the *acetabulum* of the *oſſa innominata*, which affords its round head a ſecure and extenſive play, can be moved to every ſide; but is reſtrained in its motion outwards, by the high brims of the cavity, and by the *round* ligament; for otherwiſe, the head of the bone would have been frequently thurſt out at the breach of the brims on the inſide, which allows the thigh to move conſiderably inwards.—The body of this bone enjoys little or no rotatory motion, though the head moſt commonly moves round its own axis; becauſe the oblique progreſs of the neck and head from the bone is ſuch, that the rotatory motion of the head can only bring the body of the bone forwards and backwards: Nor is this head, as in the arm, ever capable of being brought to a ſtraight direction with its body; ſo far however as the head can move within the cavity backwards and forwards, the reſt of the bone may have a partial rotation.—When the thigh bone reſiſts the actions of its muſcles more than the trunk of the body can then do, as in ſtanding, theſe muſcles have their effect on the trunk, cauſing it to bend forward, raiſing it up, inclining it to the one or the other ſide, twiſting it obliquely, *&c.* which the rolling of the *acetabula* of the *oſſa innominata* on the round heads of the thigh-bones is well fitted for.—The *os femoris* is articulated below to the *tibia* and *rotula* in the manner afterwards to be deſcribed.

The nearneſs of the ſmall neck to the round head of the thigh-bone, and its upper end being covered with very thick muſcles, make greater difficulty in diſtinguiſhing between a luxation and fracture here than in any other part of the body.

The *LEG* (*b*) is compoſed, according to the common

(*b*) Κνημη, crus, tibia.

mon account, of two bones, *tibia* and *fibula*, though it ſeems to have a very good title to a third, the *rotula*; which bears a ſtrong analogy to the *olecranon* of the *ulna*, and moves always with the other two.

TIBIA, (*c*), ſo called from its reſemblance to an old muſical pipe or flute, is the long thick triangular bone, ſituated at the internal part of the leg, and continued in almoſt a ſtraight line from the thigh-bone.

The upper end of the *tibia* is large, bulbous, and ſpongy, and is divided into two cavities, by a rough irregular protuberance (*d*), which is hollow at its moſt prominent part, as well as before and behind. The anterior of the two ligaments that compoſe the great *croſs* one, is inſerted into the middle cavity, and the depreſſion behind receives the poſterior ligament.—The two broad cavities at the ſides of this protuberance are not equal; for the internal is oblong and deep, to receive the internal *condyle* of the thigh-bone: while the external is more ſuperficial and rounder, for the external *condyle*.—In each of theſe two cavities of a recent ſubject, a ſemilunar cartilage is placed, which is thick at its convex edge, and becomes gradually thinner towards the concave or interior edge.—The middle of each of theſe cartilages is broad, and the ends of them turn narrower and thinner, as they approach the middle protuberance of the *tibia*.—The thick convex edge of each cartilage is connected to the capſular and other ligaments of the articulation, but ſo near to their riſe from the *tibia*, that the cartilages are not allowed to change place far; while the narrow ends of the cartilages becoming almoſt ligaments, are fixed at the inſertion of the ſtrong croſs ligament into the *tibia*, and ſeem to have their ſubſtance united with it; therefore a circular hole is left between each cartilage and the ligament, in which the moſt prominent convex part of each condyle of the thigh-bone moves.—The circumference of theſe

(*c*) Προκνημιον, ὀντικνημιον, focile majus, arundo major, canna major, canna domeſtica cruris.

(*d*) Διαφυσις, ἐξοχη νευροχονκρωδης, tuber, tuberculum.

these cavities is rough and unequal for the firm connection of the ligaments of the joint.—Immediately below the edge at its back-part, two rough flatted protuberances stand out: Into the internal, the tendon of the *semimembranosus* muscle is inserted; and a part of the cross ligament is fixed to the external.—On the outside of this last tubercle, a smooth slightly-hollowed surface is formed by the action of the *poplitæus* muscle.

Below the fore-part of the upper end of the *tibia*, a considerable rough protuberance (*e*) rises, to which the strong tendinous ligament of the *rotula* is fixed.—On the internal side of this, there is a broad scabrous slightly-hollowed surface, to which the internal long ligament of the joint, the *aponeurosis* of the *vastus internus*, and the tendons of the *seminervosus*, *gracilis*, and *sartorius*, are fixed.—The lowest part of this surface is therefore the place where the *tibia* ought to be sawed through in an amputation, so as not to have too long and troublesome a stump, and, at the the same time, to preserve its motions, by saving the proper muscles.—Below the external edge of the upper end of the *tibia*, there is a circular flat surface, covered in a recent subject with cartilage, for the articulation of the *fibula*;—between which and the anterior knob, there is a rough hollow from which the *tibialis anticus*, and *extensor digitorum longus*, take their origin.—From the smooth flat surface, a ridge runs obliquely downwards and inwards, to give rise to part of the *solæus*, *tibialis posticus*, and *flexor digitorum longus*, and insertion to the *aponeurosis* of the *semimembranosus* which covers the *poplitæus*, and to some of the external fibres of this last named muscle.—At the inside of this ridge an oblique plain surface is left, where the greatest part of the *musculus poplitæus* is inserted.—The remaining body of the *tibia* is triangular.—The anterior angle is very sharp, and is commonly called the *spine* or *shin* (*f*). This ridge is not straight;

(*e*) Ἀντικνήμιον, anterior tuber.

(*f*) Ἄκανθα, spina, crea, linea prima tibiæ, angulus acutus.

raight; but turns firſt inwards, then outwards, and ıſtly inwards again.—The plain internal ſide is nooth and equal, being little ſubjected to the acons of muſcles; but the external ſide is hollowed ɔove by the *tibialis anticus*, and below by the *extenr digitorum longus* and *extenſor pollicis longus*.—The vo angles behind theſe ſides are rounded by the acon of the muſcles;—the poſterior ſide comprehended ɛtween them is not ſo broad as thoſe already menoned, but is more oblique and flatted by the action the *tibialis poſticus* and *flexor digitorum longus*.—Some ay above the middle of the bone the internal angle terinates, and the bone is made round by the preſſure the *muſculus ſolæus*.—Near to this, the paſſage of the edullary veſſels is ſeen ſlanting obliquely downwards.

The lower end of the *tibia* is made hollow, but ſo a ſmall protuberance riſes in the middle.—The inrnal ſide of this cavity, which is ſmooth, and in recent ſubject is covered with cartilage, is proıced into a conſiderable proceſs, commonly naml *malleolus internus* (*g*); the point of which is vided by a notch, and from it ligaments are ſent ıt to the foot.—We ought to obſerve here, that this ternal *malleolus* is ſituated more forwards than the ternal condyle of the upper end of this bone; which neceſſary to be remembered in reducing a fracture the leg (*h*).—The external ſide of this end of the *ia* has a rough irregular ſemilunar cavity formed in for receiving the lower end of the *fibula*.—The ſterior ſide has two lateral grooves, and a ſmall iddle protuberance. In the internal depreſſion, the ndons of the *muſculus tibialis poſticus* and *flexor digirum longus* are lodged; and in the external, the ndon of the *flexor longus pollicis* plays.—From the iddle protuberance, ligamentous ſheaths go out, r tying down theſe tendons.

The articulations and motions of the *tibia* ſhall be explained,

(*g*) Σφυρον, πτεον, talus, clavicula, clavilla interior, clavilla doſtica.

(*h*) Winſlow, Expoſition anatomique des os ſecs, ſect. 865.

explained, after all the three bones of the leg are described.

Both the ends of the *tibia* are cartilages at birth, and become afterwards *epiphyſes*.

FIBULA (*i*) is the ſmall long bone, placed on the outſide of the leg, oppoſite to the external angle of the *tibia*; the ſhape of it is irregularly triangular.

The head of the *fibula* has a ſuperficial circular cavity formed on its inſide, which, in a recent ſubject is covered with a cartilage, but ſo cloſely connecte to the *tibia* by ligaments, as to allow only a ſmal motion backwards and forwards.—This head is pro tuberant and rough on its outſide, where a ſtron round ligament and the *muſculus biceps* are inſerted and below the back-part of its internal ſide, a tuber cle may be remarked, that gives riſe to the ſtron tendinous part of the *ſolæus* muſcle.

The body of this bone is a little crooked inwarc and backwards, which figure is owing to the actior of the muſcles; but is ſtill further increaſed by nu ſes, who often hold children careleſsly by the legs.— The ſharpeſt angle of the *fibula* is forwards, on eac ſide of which the bone is conſiderably, but unequall depreſſed by the bellies of the ſeveral muſcles th riſe from, or act upon it; and, in old people, the muſcles make diſtinct ſinuoſities for themſelves.— The external ſurface of the *fibula* is depreſſed obliqu ly from above downwards and backwards, by the tw *peronæi*.—Its internal ſurface is unequally divided i to two narrow longitudinal planes, by an oblique rid extended from the upper part of the anterior angl to join with the lower end of the internal ang To this ridge the ligament ſtretched between the t bones of the leg is connected.—The anterior of t two planes is very narrow above, where the *exten longus digitorum* and *extenſor longus pollicis* ariſe fr it; but is broader below, where it has the print the *nonus Veſalii*.—The poſterior plane is broad a hollo

(*i*) Παραχνημιον, perone, focile minus, arundo minor, canna nor cruris, ſura, radius.

ollow, giving origin to the larger ſhare of the *tibialis oſticus.*—The internal angle of this bone has a tendinous membrane fixed to it, from which fibres of the *lexor digitorum longus* take their riſe.—The poſterior urface of the *fibula* is the plaineſt and ſmootheſt, but s made flat above by the *ſolæus*, and is hollowed beow by the *flexor pollicis longus.*—In the middle of this urface the canal for the medullary veſſels may be een ſlanting downwards.

I have taken particular notice of the entry and diection of the medullary veſſels of the large bones of he extremities (*a*); becauſe, in ſeveral chirurgical aſes, a ſurgeon, who is ignorant of this, may do niſchief to his patient. Thus, for example, if theſe eſſels are opened very near to their entry into the one, or while they are in the oblique paſſage through t, an obſtinate hæmorrhagy may enſue: For the areries being connected to the bony paſſage, ſtyptics, nd other like corrugators, are vainly applied; comreſſing inſtruments can do no ſervice, and ligatures annot be employed.—There ſeems to be a particular leſign in the contrivance of theſe canals; thoſe in the *s humeri*, *tibia*, and *fibula*, running obliquely downvards from their external entry; whereas in the *ralius*, *ulna*, and *os femoris*, they ſlant upwards, whereoy the arteries and nerves which are ſent into theſe hree laſt bones, muſt ſuffer a conſiderable reflection efore they come at the *cancelli*. The reaſon of this liverſity may perhaps be, that the arteries, which are o ſmall within the bones as to have no ſtrong conractile propelling force in their coats, and where they re not aſſiſted by the action of any moving neighouring organ, ſhould have, at leaſt in their paſſage hrough the bone, a favourable deſcent for their liquids: Which, it is evident, they have in the deſcending oblique paſſages formed for them in the firſt laſs of bones, to wit, the *os humeri*, *tibia*, and *fibula*, which are generally depending; and they alſo moſt requently acquire the like advantage in the *radius*, *ulna*,

(*a*) Havers, Oſteolog. nov. diſc. I. p. 59.

ulna, and *os femoris*; becaufe the hand, in the moft natural pofture, is higher than the elbow; and when we fit or lie, the lower end of the thigh bone comes to be at leaft as high raifed as the upper. In ftanding and walking, or when the arms are moved, the blood muft indeed afcend as it paffes through the bones of the fore-arm and thigh; but the preffure of the mufcles, then in action, on the veffels, before they enter the bones, is fufficient to compenfate the difadvantage of their courfe. This reafoning feems to be ftill enforced, by obferving, that this paffage is always nearer the upper than the lower ends of thefe bones.

The lower end of the *fibula* is extended into a fpongy oblong head, on the infide of which is a convex, irregular, and frequently a fcabrous furface, that is received by the external hollow of the *tibia*, and fo firmly joined to it by a very thin intermediate cartilage and ftrong ligaments, that it fcarce can move.—Below this, the *fibula* is ftretched out into a coronoid procefs, that is fmooth, covered with cartilage on its internal fide, and is there contiguous to the outfide of the firft bone of the foot, the *aftragalus*, to fecure the articulation. This procefs, named *malleolus externus*, being fituated farther back than the internal *malleolus*, and in an oblique direction, obliges us naturally to turn the fore-part of the foot outwards (*b*). At the lower internal part of this procefs, a fpongy cavity for mucilaginous glands may be remarked; from its point ligaments are extended to the *aftragalus*, *os calcis*, and *os naviculare*, bones of the foot; and from its infide fhort ftrong ones go out to the *aftragalus*. On the back-part of it a finuofity is made by the tendons of the *peronæi* mufcles.—When the ligament extended over thefe tendons from the one fide of the depreffion to the other is broke, ftretched too much, or made weak by a fprain, the tendons frequently ftart forwards to the outfide of the *fibula*.

The conjunction of the upper end of the *fibula* with the *tibia* is by plain furfaces tipped with cartilage

(*b*) Winflow, Memoires de l'acad. des fciences, 1722.

ge, and at its lower end the cartilage ſeems to glue e two bones together, not, however, ſo firmly in ung people, but that the motion at the other end ſuch a long *radius* is very obſerveable.—In old ſubcts I often ſee the two bones of the leg grown tother at their lower ends.

The principal uſe of this bone is to afford origin d inſertion to muſcles; the direction of which may a little altered on proper occaſions, by its upper rt ſhuffling backwards and forwards.—It likewiſe lps to make the articulation of the foot more ſecure d firm.—The ends of the *tibia* and *fibula* being ger than their middle, a ſpace is here left, which filled up with ſuch another ligament as I deſcribed tended between the bones of the fore-arm; and ich is alſo diſcontinued at its upper part, where e *tibialis anticus* immediately adheres to the *ſolæus* d *tibialis poſticus*; but every where elſe it gives orin to muſcular fibres (*a*).

Both the ends of this bone are cartilaginous in a e child, and aſſume the form of *appendices* before y are united to its body.

ROTULA (*b*) is the ſmall flat bone ſituated at the fe-part of the joint of the knee.—Its ſhape reſemes the common figure of the heart with its point wnwards.—The anterior convex ſurface of the *rota* is pierced by a great number of holes, into which fires of the ſtrong ligament that is ſpread over it, er.—Behind, its ſurface is ſmooth, covered h cartilage, and divided by a middle convex ridge o two cavities, of which the external is largeſt; d both are exactly adapted to the pulley of the *os foris*, on which they are placed in the moſt ordinaunſtraining poſtures of the leg; but when the leg much bended, the *rotula* deſcends far down on the dyles; and when the leg is fully extended, the *rula* riſes higher, in its upper part, than the pulley

T of

(*a*) Weitbrecht, Syndeſmolog. p. 156.

(*b*) Ἐπιμυλίς, μυλακρίς, κόγχος, ἐπιγονατίς, πλακοῦντιον, pateia, mola, genu, ſcutiforme os, cartilaginoſum, diſciforme, oculus ge.

of the thigh-bone.—The plain ſmooth ſurface is ſur rounded by a rough prominent edge, to which th capſular ligament adheres:—Below, the point of th bone is ſcabrous, where the ſtrong tendinous ligamen from the tubercle of the *tibia* is fixed.—The upper hori zontal part of this bone is flatted and unequal, wher the tendons of the extenſors of the leg are inſerted.

The ſubſtance of the *rotula* is cellular, with ver thin external firm plates: But then theſe *cells* are ſ ſmall, and ſuch a quantity of bone is employed i their formation, that ſcarce any bone of its bulk ſo ſtrong. Beſides, it is covered all over with a thic ligament, (as it was obſerved, that this ſort of bone generally is), to connect its ſubſtance, and is moveab to one ſide or other; therefore is ſufficiently ſtrong t reſiſt the ordinary actions of the large muſcles th are inſerted into it, or any common external forc applied to it; while a fixed proceſs, ſuch as the *ol cranon*, would not have been ſufficient to bear tl whole weight of our bodies, which frequently fal on it, and would have hindered the rotatory motic of the leg. Notwithſtanding theſe precautions preſerve this bone from ſuch injuries, yet I have ſee a tranſverſe fracture in it, when, by the report of tl patient, and of the people about him, and by tl want of ſwelling, diſcolouring, or other mark bruiſe or contuſion, it was plain the bone was brok by the violent ſtraining effort of the muſcles (c Though my patient recovered the uſe of the joint the knee, yet I think it reaſonable to believe, that tl ſort of fracture is commonly attended with difficul of motion, after the broken parts of the *rotula* a reunited; becauſe the callous matter probably exten itſelf into the cavity of the joint, where it eith grows to ſome of the parts, or makes ſuch an inequ lity on the ſurface of this bone, as does not allow to perform the neceſſary motions on the condyles the *femur* (*d*).

(*c*) See Ruyſch. Obſerv. anat. chirurg. obſ. 3.
(*d*) Pare, liv. 15. cap. 22.

At the ordinary time of birth, the *rotula* is entire- cartilaginous, and fcarcely affumes a bony nature foon as moft *epiphyfes* do.

The parts which conftitute the joint of the knee :ing now defcribed, let us examine what are its otions, and how performed.—The two principal otions are flection and extenfion.—In the former of efe, the leg may be brought to a very acute angle ith the thigh, by the condyles of the thigh-bones :ing round and made fmooth far backwards. In :rforming this the *rotula* is pulled down by the *tibia*. -When the leg is to be extended, the *rotula* is drawn)wards, confequently the *tibia* forwards by the *ex- nfor* mufcles; which, by means of the protuberant int, and of this thick bone with its ligament, have effect the chord, with which they act, fixed to the *ia* at a confiderable angle, therefore act with ad- ntage; but are reftrained from pulling the leg far- ier than to a ftraight line with the thigh, by the fterior part of the *crofs* ligament, that the body ght be fupported by a firm perpendicular column: r at this time the thigh and leg are as little move- le in a rotatory way, or to either fide, as if they :re one continued bone.—But when the joint is a lit- bended, the *rotula* is not tightly braced, and the fterior ligament is relaxed; therefore this bone may moved a little to either fide, or with a fmall rota- n in the fuperficial cavities of the *tibia*; which is ne by the motion of the external cavity backwards d forwards, the internal ferving as a fort of axis). Seeing then one part of the *crofs* ligament is uated perpendicularly, and the pofterior part is etched obliquely from the internal condyle of the gh outwards, that pofterior part of the *crofs* liga- nt prevents the leg's being turned at all inwards; t it could not hinder it from turning outwards al- oft round, was not that motion confined by the la- al ligaments of this joint, which can yield little.

T 2 This

) Winflow, Expofition anatomique du corps humain, traité des ecs, § 976.

This rotation of the leg outwards is of good advantage to us in croffing our legs, and turning out fee outwards, on feveral neceffary occafions; though i is altogether fit this motion fhould not be very large to prevent frequent luxations here. While all thef motions are performing, the part of the *tibia* tha moves immediately on the condyles is only fo much as is within the cartilaginous rings, which, by th thicknefs on their outfides, make the cavities of th *tibia* more horizontal, by raifing their external fid where the furface of the *tibia* flants downwards. B this means the motions of this joint are more equa and fteady than otherwife they would have been The cartilages being capable of changing a little thei fituation, are fit for doing this good office in the different motions and poftures of the member, and likewife contribute to make the motions larger and quicker

On account of the very large furface of the bone forming the joint of the knee, and the many ftron ligaments connecting them, luxations feldom happe here. But thefe very ligaments, the *aponeurofis* paffing over this joint, the quantity of fat and mucilaginous glands neceffary for lubricating it, make i more fubject to *white-fwellings*, dropfies, and fuc other diforders, than any other joint of the body.

The *FOOT* is divided, as well as the hand, int three parts, *viz. tarfus*, *metatarfus*, and *toes*: In th defcription of which, the feveral furfaces fhall b named, according to their natural fituation, *viz.* th *broad* of the foot, fhall be called fuperior; the *fol* inferior; the fide on which the great toe is, internal that where the little toe is, external.

The *tarfus* (*a*) confifts of feven fpongy bones; to wi the *aftragalus*, *os calcis*, *naviculare*, *cuboides*, *cuneiform externum*, *cuneiforme medium*, and *cuneiforme internum*

The *aftragalus* is the uppermoft of thefe bones.— The *os calcis* is below the *aftragalus*, and is confide ably prominent backwards beyond the other bones, t form the heel.—The *os naviculare* is in the middle

th

(*a*) Raffetta.

ie internal ſide of the *tarſus*.—The *os cuboides* is the ;oſt external of the row of four bones at its fore-part. -The *os cuneiforme externum* is placed at the inſide ' the *cuboid*.—The *cuneiforme medium* is between the *ternal* and *internal cuneiform* bones, and the *internal neiform* is put at the internal ſide of the foot.

That the deſcription of theſe bones may not be ımoderately ſwelled with repetition, I deſire, once r all, to obſerve, That wherever a ridge is men-)ned, without a particular uſe aſſigned, a ligament underſtood to be fixed to it; or where a ſpongy ugh cavity, depreſſion, or *foſſa* is remarked, without ıming its uſe, a ligament is inſerted, and mucilagi-)us glands are lodged: For ſuch will occur in the de-il of each of theſe bones.

The upper part of the *aſtragalus* (*b*) is formed into large ſmooth head (*c*), which is ſlightly hollowed the middle; and therefore reſembles a ſuperficial lley, by which it is fitted to the lower end of the *ia*.—The internal ſide of this head is flat and ſmooth, play on the internal *malleolus*.—The external ſide ls alſo ſuch a ſurface, but larger, for its articulation 'th the external *malleolus*.—Round the baſe of this lad there is a rough *foſſa*; and, immediately before t: head, as alſo below its internal ſmooth ſurface, ': find a conſiderable rough cavity.

The lower ſurface of the *aſtragalus* is divided by : irregular deep rough *foſſa*; which at its internal d is narrow, but gradually widens, as it ſtretches liquely outwards and forwards.—The ſmooth ſur-:e, covered with cartilage, behind this *foſſa*, is large, long, extended in the ſame oblique ſituation with t: *foſſa*, and concave, for its conjunction with the *calcis*.—The back-part of the edge of this cavity is pduced into two ſharp-pointed rough proceſſes, be-teen which is a depreſſion made by the tendon of t: *flexor pollicis longus*.—The lower ſurface before

 the

b) Ἀστριος, talus, baliſtæ os, malleolus, chaib, quatrio, os teſſe-r claviculæ, unciforme.

c) Τετρωρος.

the *foſſa* is convex, and compoſed of three diſtinct ſmooth planes. The long one behind, and the exterior or ſhorteſt, are articulated with the heel-bone; while the internal, which is the moſt convex of the three, reſts and moves upon a cartilaginous ligament, that is continued from the *calcaneum* to the *os ſcaphoides*. Without which ligament, the *aſtragalus* could not be ſuſtained, but would be preſſed out of its place by the great weight it ſupports, and the other bones of the *tarſus* would be ſeparated. Nor would a bone be fit here, becauſe it muſt have been thicker than could conveniently be allowed; otherwiſe it would break, and would not prove ſuch an eaſy bending baſe, to leſſen the ſhock which is given to the body in leaping, running, &c.

The fore-part of this bone is formed into a convex oblong ſmooth head, called by ſome its proceſs, which is received by the *os naviculare*. Round the root of this head, eſpecially on the upper ſurface, a rough *foſſa* may be remarked.

The *aſtragalus* is articulated above to the *tibia* and *fibula*, which together form one cavity. Though, in this articulation, the bones have prominencies and cavities ſo ſmall, as might allow motions in all directions; yet the flection and extenſion are the moſt conſiderable, the other motions being confined by the *malleoli*, and by the ſtrong ligaments which go out from the points of theſe proceſſes to the *aſtragalus* and *os calcis*.—When the foot is bended, ſo far as it is commonly when we ſtand, no lateral or rotatory motion is allowed in this joint; for then the head of the *aſtragalus* is ſunk deep between the *malleoli*, and the ligaments are tenſe; but when the foot is extended, the *aſtragalus* can move a little to either ſide, and with a ſmall rotation. By this contrivance the foot is firm, when the weight of the body is to be ſupported on it; and when a foot is raiſed, we are at liberty to direct it more exactly to the place we intend next to ſtep upon.—The *aſtragalus* is joined below, to the *os calcis*; and before, to the *os naviculare*, in

he manner to be explained, when theſe bones are eſcribed.

A conſiderable ſhare of this bone is oſſified in a ew-born infant.

Calcaneum (*d*) is the largeſt bone of the ſeven.—ehind, it is formed into a large knob, commonly alled the *heel*: The ſurface of which is rough be-ind, where the *tendo Achillis* is inſerted into it; and bove it, it is hollow and ſpongy. Farther forwards, n the upper ſurface of the *calcaneum*, there is an ir-egular oblong ſmooth convexity, adapted to the con-avity at the back-part of the *aſtragalus*: And be-ond this a narrow *foſſa* is ſeen, which divides it from wo ſmall concave ſmooth ſurfaces, that are joined to e fore-part of the *aſtragalus*.—Behind the poſterior f theſe ſmooth ſurfaces, which is the largeſt, a ſmall nuoſity is made by the tendon of the *flexor digitorum ngus*; at the fore-part of which a ſmall rough pro-berance appears, that gives riſe to the *muſculus ex-nſor digitorum brevis*.

The external ſide of this bone is flat, with a ſuper-cial *foſſa* running horizontally, in which the tendon f the *muſculus peronæus longus* is lodged.—The inter-al ſide of the heel-bone is hollowed, for lodging the rigin of the *maſſa cornea Jac. Sylvii*, and for the fe paſſage of tendons, nerves, and arteries.—Under e ſide of the internal ſmooth concavity, a particular roove is made by the tendon of the *flexor pollicis lon-us*; and from the thin protuberance on this internal de, the cartilaginous ligament that ſupports the *a-ragalus*, goes out to the *os naviculare*; on which li-ament, and on the edge of this bone to which it is xed, the groove is formed for the tendon of the *exor digitorum profundus*.

The lower ſurface of this bone is preſſed flat at the ack-part, by the weight of our bodies; and imme-iately before this plane, there are two tubercles, om the internal of which the *muſculus abductor polli-s*, *flexor digitorum ſublimis*, as alſo part of the *apo-neuroſis*

(*d*) Os calcis, πτερνα, calcar pedis.

neurosis plantaris, and of the *abductor minimi digiti*, have their origin; and the other part of the *abductor minimi digiti* and *aponeurosis plantaris* rises from the external.—Before these protuberances this bone is concave, for lodging the flexor muscles; and at its fore-part we may observe a rough depression, from which, and a tubercle behind it, the ligament goes out that prevents this bone to be separated from the *os cuboides*.

The fore-part of the *os calcis* is formed into an oblong pulley-like smooth surface, which is circular at its upper external end, but is pointed below. This smooth surface is fitted to the *os cuboides*.

Though the surfaces by which the *astragalus* and *os calcis* are articulated, seem fit enough for motion; yet the very strong ligaments by which these bones are connected, prevent it, and render this principal part of our base, which rests on the ground, *to wit*, the *os calcis*, firm.

A large share of the heel-bone is ossified at the ordinary time of birth, and the large knob appears afterwards in form of an *epiphyse*.

Os naviculare (*e*), is somewhat circular.—It is formed into an oblong concavity behind for receiving the anterior head of the *astragalus*.—On the upper surface there is a rough *fossa*.—Below, the *os naviculare* is very unequal and rough; but hollow for the safety of the muscles.—On its inside a large knob rises out, from which the *abductor pollicis* takes in part its origin, the tendon of the *tibialis posticus* is inserted into it, and to it two remarkable ligaments are fixed; the first is the strong one, formerly mentioned, which supports the *astragalus*; the second is stretched from this bone obliquely cross the foot, to the metatarsal bones of the middle toe, and of the toe next to the little one.—On the outside of the *os naviculare* there is a semicircular smooth surface, where it is joined to the *os cuboides*.—The fore-part of this bone is all covered

(*e*) Σκαφοειδης, os cymbæ.

overed with cartilage, and is divided into three mooth planes, fitted to the three *oſſa cuneiformia.*

The *os naviculare* and *aſtragalus* are joined as a ball nd ſocket, and the *naviculare* moves in all directions n turning the toes inwards, or in raiſing or depreſ-ng either ſide of the foot, though the motions are reatly reſtrained by the ligaments which connect his to the other bones of the *tarſus.*—A weakneſs of heſe ligaments cauſes ſometimes an unnatural turn of he fore-part of the foot inwards.

The *os naviculare* is wholly cartilaginous in a new-orn infant.

OS CUBOIDES (*a*) is a very irregular cube.—Behind, it is formed into an oblong unequal conca-ity, adapted to the fore-part of the *os calcis.*—On ts internal ſide, there is a ſmall ſemicircular ſmooth avity, to join the *os naviculare.*—Immediately be-ore which, an oblong ſmooth plane is made by the *s cuneiforme externum.*—Below this, the bone is hol-ow and rough.—On the internal ſide of the lower urface, a round protuberance and *foſſa* are found, where the *muſculus abductor pollicis* has its origin. On the external ſide of this ſame ſurface, there is a ound knob, covered with cartilage; immediately efore which, a ſmooth *foſſa* may be obſerved, in which the tendon of the *peronæus primus* runs ob-iquely croſs the foot; and on the knob, the thin flat artilage proper to this muſcle plays; in place of which, ſometimes a bone is found: More externally han the knob, a rough hollow is made, for the trong ligaments ſtretched betwixt this bone and the *s calcis.*—Before, the ſurface of the *os cuboides* is flat, mooth, and ſlightly divided into two planes, for ſu-taining the *os metatarſi* of the little toe, and of the oe next to it.

The form of the back-part of the *os cuboides*, and he ligaments connecting the joint there with the *os calcis*,

(*a*) Πολυμορφον, cubiforme, quadratum, grandinoſum, varium, eſſeræ, multiforme.

calcis, both concur in allowing little motion in this part.

The oſſification of this bone is ſcarcely begun at the birth.

Os cuneiforme externum (*b*), if we regard its ſituation or *medium* by its bulk, is much of the ſhape of a wedge, being broad and flat above, with long ſides running obliquely downwards, and terminating in a ſharp edge.—The upper ſurface of this bone is an oblong ſquare.—The one behind is nearly a triangle, but not complete at the inferior angle, and is joined to the *os naviculare*.—The external ſide is an oblong ſquare, divided as it were by a diagonal; the upper half of it is ſmooth, for its conjunction with the *os cuboides*: The other is a ſcabrous hollow, and in its ſuperior anterior angle a ſmall ſmooth impreſſion is made by the *os metatarſi* of the toe next to the little one.—The internal ſide of this bone is alſo quadrangular, with the fore-part of its edge made flat and ſmooth by the *os metatarſi* of the toe next to the great one, and the back-part is alſo flat and ſmooth where the *os cuneiforme medium* is contiguous to it.—The fore-part of this bone is an oblong triangle, for ſuſtaining the *os metatarſi* of the middle toe.

Os cuneiforme medium, or *minimum*, is ſtill more exactly the ſhape of a wedge than the former.—Its upper part is ſquare;—its internal ſide has a flat ſmooth ſurface above and behind, for its conjunction with the following bone; with a ſmall rough *foſſa* below; and a conſiderable ſhare of it is rough and hollow.—The external ſide is ſmooth and a little hollowed, where it is contiguous to the laſt deſcribed bone.—Behind, this bone is triangular, where it is articulated with the *os naviculare*; and it is alſo triangular at its fore-part, where it is contiguous to the *os metatarſi* of the toe next to the great one.

Os cuneiforme maximum, or *internum*, differs from the two former in its ſituation, which is more oblique than theirs.—Beſides, its broad thick part is placed

(*b*) Chalcoideum externum.

laced below, and the ſmall thin point is above and utwards; while its under broad ſurface is concave, or allowing a ſafe paſſage to the flexors of the great oe.—The ſurface of this *os cuneiforme* behind, where is joined to the *os naviculare*, is hollow, ſmooth, nd of a circular figure below, but pointed above.—The external ſide conſiſts of two ſmooth and flat urfaces, whoſe direction is nearly at right angles vith each other. With the poſterior, that runs obiquely from below forwards and upwards, the *os uneiforme minimum* is joined; and with the anterior, whoſe direction is longitudinal, the *os metatarſi* of the oe next to the great one is connected.—The fore-art of this bone is ſemilunar, but flat and ſmooth, or ſuſtaining the *os metatarſi* of the great toe.—The nternal ſide is ſcabrous, with two remarkable tu-ercles below, from which the *muſculus abductor pollicis* riſes, and the *tibialis anticus* is inſerted into its up-er part.

The three cuneiform bones are all ſo ſecured by li-aments, that very little motion is allowed in any of hem; and they are cartilaginous in a *fœtus* of nine nonths.

Theſe ſeven bones of the *tarſus*, when joined, are onvex above, and leave a concavity below, for lodg-ng ſafely the ſeveral muſcles, tendons, veſſels, and erves, that ly in the ſole of the foot.—In the recent ubject, their upper and lower ſurfaces are covered vith ſtrong ligaments which adhere firmly to them; nd all the bones are ſo tightly connected by theſe nd the other ligaments, which are fixed to the ough ridges and *foſſæ* mentioned in the preceding de-cription of the particular bones, that, notwithſtand-ng the many ſurfaces covered with cartilage, ſome f which are of the form of the very moveable ar-culations, no more motion is here allowed, than nly to prevent too great a ſhock of the fabric of the ody in walking, leaping, &c. by falling on too ſolid baſe; which, if it was one continued bone, would kewiſe be much more liable to be broken; and in order

order to make our foot accommodate itſelf to the ſurfaces we tread on, by becoming more or leſs hollow, or by raiſing or depreſſing either ſide of it, as might be judged by what was ſaid of the particular bones.

Sprains here occaſion, as in the wriſt, great pain and obſtinate tumours, which too often cauſe carious bones.

METATARSUS (*c*) is compoſed of five bones, which, in their general characters, agree with the metacarpal bones; but may be diſtinguiſhed from them by the following marks: 1. They are longer, thicker, and ſtronger. 2. Their anterior round ends are not ſo broad, and are leſs in proportion to their baſes. 3. Their bodies are ſharper above and flatter on their ſides, with their inferior ridge inclined more to the outſide. 4. The tubercles at the lower parts of the round head are larger.

The firſt or internal metatarſal bone is eaſily diſtinguiſhed from the reſt by its thickneſs.—The one next to it is the longeſt, and with its ſharp edge almoſt perpendicular.—The others are ſhorter and more oblique, as their ſituation is more external. Which general remarks, with the deſcription I am now to give of each, may teach us to diſtinguiſh them from each other.

Os metatarſi pollicis is by far the thickeſt and ſtrongeſt, as having much the greateſt weight to ſuſtain. Its baſe is oblong, irregularly concave, and of a ſemilunar figure, to be adapted to the *os cuneiforme maximum*.—The inferior edge of this baſe is a little prominent and rough, where the tendon of the *peronæus primus* muſcle is inſerted.—On its outſide an oblique circular depreſſion is made by the ſecond metatarſal bone.—Its round head has generally on its fore-part a middle ridge, and two oblong cavities, for the *oſſa ſeſamoidea;* and on the external ſide a depreſſion is made by the following bone.

Os

(*c*) Στηθος, πεδιον, planta, planum, veſtigium, ſolium, pectus, præcordium, pectuſculum.

Os metatarsi of the second toe, is the longest of he five, with a triangular base supported by the *os uneiforme medium* and the external side produced into process; the end of which is an oblique smooth lane, joined to the *os cuneiforme externum.*——Near ie internal edge of the base, this bone has two small epressions, made by the *os cuneiforme maximum*, beween which is a rough cavity.—Farther forwards we iay observe a smooth protuberance, which is joined) the foregoing bone.—On the outside of the base e too oblong smooth surfaces, for its articulation ith the following bone; the superior smooth surface eing extended longitudinally, and the inferior perendicularly; between which there is a rough *fossa*.

Os metatarsi of the middle toe, is the second in ngth.—Its base, supported by the *os cuneiforme exrnum*, is triangular, but slanting outwards, where ends in a sharp-pointed little process; and the angle low is not completed.

The internal side of this base is adapted to the eceding bone; and the external side has also two iooth surfaces covered with cartilage, but of a difrent figure; for the upper one is concave, and, beg round behind, turns smaller as it advances forrds; and the lower surface is little, smooth, conx, and very near the edge of the base.

Os metatarsi of the fourth toe, is near as long as e former, with a triangular slanting base joined to e *os cuboides*, and made round at its external angle, ving one hollow smooth surface on the outside, iere it is pressed upon by the following bone, and o on the internal side, corresponding to the forr bone; behind which is a long narrow surface pressed by the *os cuneiforme externum*.

Os metatarsi of the little toe, is the shortest, situat with its two flat sides above and below, and with t ridges laterally.—The base of it, part of which ts on the *os cuboides*, is very large, tuberous, and pduced into a long-pointed process externally, where

part of the *abductor minimi digiti* is fixed; and inte its upper part the *peronæus ſecundus* is inſerted.—It inſide has a flat conoidal ſurface, where it is conti guous to the preceding bone.

When we ſtand, the fore-ends of theſe metatarſa bones, and the *os calcis*, are our only ſupporters; an therefore it is neceſſary they ſhould be ſtrong, an ſhould have a confined motion.

The bones of the *TOES* are much a-kin to thoſ of the thumb and fingers; particularly the two of th great toe are preciſely formed as the two laſt of th thumb; only their poſition, in reſpect of the othe toes, is not oblique; and they are proportionall much ſtronger, becauſe they are ſubjected to a greate force; for they ſuſtain the force with which ou bodies are puſhed forwards by the foot behind a every ſtep we make; and on them principally th weight of the body is ſupported, when we are raiſe on our tiptoes.

The three bones in each of the other four toe compared to thoſe of the fingers, differ from them i theſe particulars.—They are leſs, and ſmaller in pr portion to their lengths:——Their baſes are muc larger than their anterior ends: Their bodies are mo narrow above and below, and flatter on the ſides.-- The firſt *phalanx* is proportionally much longer th the bones of the ſecond and third, which are ve ſhort.

Of the four, the toe next to the great one, has t largeſt bones in all dimenſions, and more external the toes are leſs.—The little toe, and frequently th next to it, have the ſecond and third bones intimat ly united into one; which may be owing to th little motion, and the great preſſure they are ſubje ed to.

The toes are of good uſe to us in walking: f when the ſole is raiſed, they bring our body, with centre of gravity, perpendicular to the advanc foot.

T

The bones of the *metatarſus* and toes, are in the me condition in children as thoſe of the *metacarpus* nd fingers.

The only bones now remaining to complete the eſcription of the ſkeleton, are the ſmall ones, which re found at the joints of the fingers and toes, and in me other parts, called

OSSA SESAMOIDEA, which are of very diffe- ent figures and ſizes, though they are generally ſaid reſemble the ſeed of the *ſeſamum*.—They ſeem to e nothing elſe than the ligaments of the articula- ons, or the firm tendons of ſtrong muſcles, or both, ecome bony, by the compreſſion which they ſuffer. hus the *ſeſamoid* bones at the beginning of the *gaſt- ocnemii* muſcles, are evidently compoſed of the ten- inous fibres only.—Theſe, at the firſt joint of the reat toe, are as plainly the ſame continued ſubſtance ith the ligaments and the tendons of the *adductor*, *exor*, *brevis*, and *abductor*.—That which is ſometimes ouble at the ſecond joint of that toe, is part of the apſular ligament; and if we enumerate the other *ſamoid* bones that are at any time found, we may bſerve all of them formed in this manner.—Their umber, figure, ſituation, and magnitude, are ſo un- ertain, that it were in vain to inſiſt on the differ- nces of each; and therefore I ſhall only in general emark,

1. That where-ever the tendons and ligaments are rmeſt, the actions of the muſcles ſtrongeſt, and the ompreſſion greateſt, there ſuch bones are moſt com- monly found.

2. That, *cæteris paribus*, the older the ſubject is in hich they are ſought, their number is greater, and heir ſize is larger.

3. The more labour any perſon is inured to, he as, *cæteris paribus*, the moſt numerous and largeſt *ſſa ſeſamoidea*.

However, as the two at the firſt joint of the great oe are much larger than any other, are early form- d, and are ſeldom wanting in an adult, we may

judge, that besides the more forcible cause of their formation, there should also be some particular advantage necessary at this place, rather than elsewhere which may possibly be, to allow the *flexor* muscles to send their tendons along this joint, secure from compression in the hollow between the two oblong sesamoid bones; while, by removing these tendons from the centre of motion, and giving them the advantage of an angle at their insertion, the force of the muscles is increased, and therefore the great superincumbent weight of our body in progression is more easily raised.

APPEN

APPENDIX.

Of the Marks of a FEMALE SKELETON.

TO finiſh the deſcription of the bones, is generally to conclude the *oſteology;* but that no part of the ſubject may be left untouched, I think it neceſſary to ſubjoin the diſtinguiſhing marks of the male and female ſkeletons; and have choſen to illuſtrate them principally in the latter; becauſe women having a more delicate conſtitution, and affording lodging and nouriſhment to their tender *fœtuſes*, till they have ſufficient ſtrength and firmneſs to bear the injuries of the atmoſphere, and contact of other more ſolid ſubſtances, their bones are frequently incomplete, and always of a make in ſome parts of the body different from thoſe of the robuſt male; which agree to the deſcription already given, unleſs where the proper ſpecialities of the female were particularly remarked; which could not be done in all places where they occur, without perplexing the order of this treatiſe: Therefore I choſe rather to ſum them up here by way of *Appendix*.

The cauſes of the following ſpecialities of the female bones may be reduced to theſe three: 1. A weak lax conſtitution. 2. A ſedentary inactive life, increaſing that conſtitution. 3. A proper frame for being mothers.

The bones of women are ſmaller in proportion to their length than thoſe of men; becauſe the force of their muſcles is not ſo great, nor is ſuch ſtrong external force applied to them to prevent their ſtretching out in length.

The depreſſions, ridges, ſcabrous ſurfaces, and other inequalities made by the muſcles, are not ſo

conſpicuous in them; becauſe their muſcles are nei ther ſo thick nor ſtrong, nor ſo much employed, t make ſo ſtrong prints on their bones.

Their *os frontis* is more frequently divided by continuation of the *ſagittal* ſuture, which depend on the firſt and ſecond general cauſes aſſigned above for the ſpecialities in their bones; as will appear af ter reflecting on the account given formerly of th middle internal ſpine of this bone.

Their *clavicles* are leſs crooked; becauſe their arm have been leſs forcibly pulled forwards, which in ou *European* women, eſpecially thoſe of diſtinction, i more hindered by their garb.

Their *ſternum* is more raiſed by long cartilages be low, that the *thorax* might be there widened in ſom proportion to what it is ſhortened by the preſſure up on the *diaphragm*, when they are with child.

The defect of bone, or the hole in the middle c the *ſternum*, is ofteneſt found in them, to allow th paſſage of the mammary veſſels, ſay ſome; but, i my opinion, this is owing to a lax conſtitution, b which the oſſification is not ſo ſoon completed as i men, where the action of the ſolids is vigorous, an the circulation of the fluids is briſk; for a muc ſmaller hole might have ſerved this purpoſe; and th branches of the internal mammary veſſels which a ſent to the external parts of the *thorax*, do not pa here, but between the cartilages of the ribs, befo theſe are joined to the *ſternum*.

The *cartilago xiphoides*, is oftener bifurcated i women than men, for the reaſon aſſigned in the pr ceding paragraph, *viz.* a leſs forcible power of oſſi cation.

The ſuperior cartilages of the ribs ſooner oſſify, t ſupport the weight of the *mammæ*.

The middle cartilages are more flat and broad b the weight of the breaſts.

The inferior cartilages are longer, for enlargin the cheſt.

We

Weak women, who have born many children when young, often have the *vertebræ* of their back bended forwards, and their *ſternum* depreſſed, or become round-ſhouldered and flat-breaſted (*a*), by the preſſure and weight of the impregnated *uterus*, and by the ſtrong action of the abdominal muſcles.

The *os ſacrum* is broader, and turned much more backwards, for enlarging the *pelvis*.

The *os coccygis* is more moveable, and much leſs bended forwards, to facilitate the birth.

The *oſſa ilium* are more hollow, and more reflected outwards, and conſequently further removed from each other, in order to widen the lower part of their *abdomen*, and for the better ſupport of the impregnated *uterus*.

The ridge on the upper part of the *os pubis*, is larger in ſuch women as have born children, being extended by the ſtrong action of the *muſculi recti abdominis*.

The cartilage between the two *oſſa pubis*, eſpecially in women who have born children, is thicker than in men, by which the *pelvis* is more capacious in females.

The conjoined ſurfaces of the *oſſa pubis*, and of the *oſſa innominata* and *ſacrum* are leſs, the angle under the *ſymphyſis* of the *oſſa pubis*, is much larger, and the arches formed below and behind by the *oſſa ilium* and *iſchium* are wider, which, with the ſtraighter *os ſacrum*, and more diſtant *tubera iſchii*, leave a larger paſſage for the excluſion of the child in birth.

The great tuberoſity of the *oſſa iſchium*, is flatter in women than in men, becauſe it is more preſſed upon in the ſedentary life which females enjoy.

In conſequence of the *pelvis* of women being wider, the articulations of their thigh-bones muſt be farther removed from each other: and therefore a larger ſpace is left for the procreation and birth of children (*b*); which diſtance of the thighs, may be one

(*a*) Cheſelden's Anatomy, book I. chap. 3.
(*b*) Albin. de oſſib. § 339.

one reaſon why women in running generally ſhuffl more from one ſide to the other than men, to preſerv the centre of gravity of their bodies from falling to far to a ſide of the joint of the thigh that ſupport them when the other is raiſed, which would en danger their tumbling to the ground.

I N D E X.

Clavicles,

Fontanell

Magnum

M.

N.

O.

P.

T.

U.

V.

W.

X.

Z.

THE

ANATOMY

OF THE

HUMAN NERVES,

AND

DESCRIPTION of the HUMAN LACTEAL SAC and DUCT.

The TENTH EDITION.

y ALEXANDER MONRO *Senior*, *M. D.* and *P. A.*

X 3

PREFACE

To the SEVENTH EDITION.

BEING informed that the following Eſſays have been uſeful to the ſtudents in anato-
ıy, I have cauſed them to be reprinted, with
ıch amendments as I thought neceſſary.

That offence might not be given, I have
:eated all the opinions concerning the diſ-
uted phyſiology of the nerves with that de-
:rence which the uncertainty of the ſub-
:ſt required; and have not only concealed the
ames of the writers whoſe ſentiments were
ifferent from mine, but have ſhunned quota-
ons from thoſe whom I approve, leſt the
nowledge of the latter ſhould be a key to diſ-
over the former by.

Deſcriptions of the very minute ramifications of
ıe nerves are obſcure to the young gentlemen
ɔr whoſe uſe I write; and therefore I have
ıken notice only of the larger branches in the
eſcription of the particular nerves.

The firſt occaſion of my publiſhing my great
Iaſter Boerhaave's doctrine concerning the
yſtole and Diaſtole of the heart, was to pre-
:nt the imputation I might have lain under of
ſſuming it to myſelf, when my worthy Maſter
ıd good friend Mr. Cheſelden inſerted it into
is anatomy, as communicated by me, without
mentioning

mentioning Boerhaave's name. Having nov taken away all grounds of ſuch imputation, an the doctrine, though ſimple and beautiful, no appearing ſufficient to account for the phæno mena of the motions of the heart, I have omit ted it in this edition.

The deſcription of the receptaculum chy and thoracic duct is more accurate, than in th common ſyſtems of anatomy; and on that ac count is here republiſhed.

The corrections and additions made in thi edition of the anatomy of the bones, and o theſe Eſſays, ſhow, that I pretend not to Per fection; but I would however wiſh, that n more faults were imputed to me than what ar really my own.

TH

THE
ANATOMY
OF THE
HUMAN NERVES.

Of the NERVES in general.

1. THE numerous turns which the *carotid* and *vertebral* arteries make before they paſs through the *dura mater*, theſe arteries having neither ſwelling muſcles nor preſſure of the atmoſphere to aſſiſt the courſe of the blood in them after they enter the ſcull, and their diviſion into innumerable communicating branches in the *pia mater*, and its proceſſes, ſhew, that the liquors muſt move more ſlowly and equally in them than in moſt other parts of the body.

2. By the aſſiſtance of injections and microſcopes, the very minute branches of theſe veſſels (§ 1.) are diſcovered to go from the *pia mater* into the *cortex*, cineritious, or aſhy-coloured part of the *cerebrum*, *cerebellum*, and *ſpinal marrow*; whereas we can only ſee longitudinal veſſels, without numerous ramifications or reticular plexuſes, in the white medullary ſubſtance of theſe parts.

3. The continuity of the *cortex* with the *medulla* of the *encephalon* and *ſpinal marrow* is obſervable with the naked eye, and is more diſtinctly ſeen with the aſſiſtance of a microſcope.

4. In

4. In diffecting the *brain* and *cerebellum*, we fee the fmall beginnings of the *medulla* proceeding from the *cortex*, and can trace its gradual increafe by the addition of more fuch white fubftance coming from the *cortex*.

5. Both thefe fubftances (§ 4.) are very fucculent; for, being expofed to the air to dry, they lofe more of their weight than moft other parts of the body do.

6. In feveral places we can obferve the *medulla* to be compofed of fibres laid at each others fides.

7. The medullary fubftance is employed in forming the white fibrous cords, which have now the name of *nerves* appropriated to them. Within the fcull we fee the nerves to be the medullary fubftance continued; and the *fpinal marrow* is all employed in forming nerves.

8. The common opinion concerning the rife of the nerves, founded on a fuperficial infpection of thofe parts, is, that the nerves are propagated from that fide of the *encephalon*, at which they go out of the fcull. But it having been remarked, after a more ftrict inquiry, and preparing the parts by maceration in water, that the medullary fibres decuffate or crofs each other in fome parts of the *medulla*; as for example, at the *corpus annulare*, and beginning of the *fpinal marrow*: And practical obfervators having related feveral examples of people whofe brain was hurt on one fide, while the morbid fymptom, palfy, appeared on the other fide of the body, of which I have feen fome inftances; and experiments made on brutes having confirmed thefe obfervations, it has been thought, that the nerves had their rife from that fide of the *encephalon*, which is oppofite to their egrefs from the fcull. It may however ftill be faid, that this laft opinion is not fully demonftrated, becaufe a decuffation in fome parts is not a proof that it obtains univerfally; and if there are examples of palfy of the fide oppofite to where the lefion of the brain was, there are alfo others, where the injury done to the brain and the palfy were both on the fame fide.

9. The

9. The nerves are compoſed of a great many hreads lying parallel to each other, or nearly ſo, at heir exit from the *medulla*.

This fibrous texture is evident at the origin of moſt of the nerves within the ſcull; and in the *cauda equina* of the *ſpinal marrow*, we can divide them into ſuch ſmall threads, that a very good eye can ſcarce perceive them; but theſe threads, when looked at with a microſcope, appear each to be compoſed of a great number of ſmaller threads.

10. How ſmall one of theſe fibrils of the nerves s, we know not; but when we conſider that every, even the moſt minute part of the body is ſenſible, and hat this muſt depend on the nerves (which all conoined, would not make a cord of an inch diameter) being divided into branches or filaments to be diſperſed through all theſe minute parts, we muſt be convinced that the nervous fibrils are very ſmall. From the examination of the *minimum viſibile*, it is demonſtrated, that each fibre in the *retina* of the eye or expanded optic nerve, cannot exceed the ſize of he 32,400 part of a hair.

11. The medullary ſubſtance, of which the nervous fibrils are compoſed, is very tender, and would not be able to reſiſt ſuch forces as the nerves are expoſed to within the bones, nor even the common force of the circulating fluids, were not the *pia mater*, and *tunica arachnoides* continued upon them; the former giving them firmneſs and ſtrength, and the latter furniſhing a cellular coat to connect the threads of the nerves, to let them lie ſoft and moiſt, and to ſupport the veſſels which go with them.

It is this cellular ſubſtance that is diſtended when air is forced through a blow-pipe thruſt into a nerve, and that makes a nerve appear all ſpongy, after being diſtended with air till it dries; the proper nervous fibrils ſhrivelling ſo in drying, that they ſcarce can be obſerved.

12. Theſe coats (§ 11.) would not make the nerves ſtrong enough to bear the ſtretching and preſſure they are

are expofed to in their courfe to the different parts o the body; and therefore, where the nerves go out a the holes in the *cranium* and *fpine*, the *dura mater* i generally wrapt clofely round them, to collect thei difgregated fibres into tight firm cords; and, that th tenfion which they may happen to be expofed to, ma not injure them before they have got this additiona coat, it is firmly fixed to the fides of the holes in th bones through which they pafs.

13. The nervous cords thus compofed of nervou fibrils, cellular coat, *pia* and *dura mater*, have fuc numerous blood-veffels, that after their arteries onl are injected, the whole cord is tinged of the colou of the injected liquor; and if the injection is pufhe violently, the cellular fubftance of the nerves is a laft diftended with it.

14. A nervous cord, fuch as has been juft now de fcribed, (§ 13.), has very little elafticity, compare with feveral other parts of the body. When cut ou of the body, it does not become obferveably fhorter while the blood-veffels contract three eighths of thei length.

15. Nerves are generally lodged in a cellular o fatty fubftance, and have their courfe in the interfti ces of mufcles, and other active organs, where the are guarded from preffure; but in feveral parts the are fo placed, as if it was intended that they fhoul there fuffer the vibrating force of arteries, or th preffure of the contracting fibres of mufcles.

16. The larger cords of the nerves divide int branches as they go off to the different parts; th branches being fmaller than the trunk from whic they come, and making generally an acute angl where they feparate.

17. In feveral places, different nerves unite into on cord, which is commonly larger than any of th nerves which form it.

18. Several nerves, particularly thofe which ar diftributed to the bowels, after fuch union, (§ 17.) fuddenly form a hard knot confiderably larger tha

ai

ıll the nerves of which it is made. Theſe knots were ːalled *corpora olivaria*, and are now generally named *ganglions*.

19. The *ganglions* have thicker coats, more numeous, and larger blood-veſſels than the nerves; ſo that hey appear more red and muſcular. On diſſecting the *anglions*, fibres are ſeen running longitudinally in heir axes, and other fibres are derived from their ides in an oblique direction to the longitudinal ones.

20. Commonly numerous ſmall nerves, which conunctly are not equal to the ſize of the *ganglion*, are ːnt out from it, but with a ſtructure no way diferent from that of other nerves.

21. The nerves ſent to the organs of the ſenſes, ɔſe there their firm coats, and terminate in a pulpy ıbſtance. The *optic nerves* are expanded into the ɔft tender webs, the *retinæ*. The *auditory nerve* has ːarce the conſiſtence of *mucus* in the *veſtibulum*, *cocha*, and *ſemicircular canals* of each ear. The *papillæ* f the noſe, tounge, and ſkin, are very ſoft.

22. The nerves of muſcles can likeways be traced ll they ſeem to loſe their coats by becoming very ſt; from which, and what we obſerved of the ſentory nerves (§ 21.), there is reaſon to conclude, that e muſcular nerves are alſo pulpy at their terminaons, which we cannot indeed proſecute by diſſection.

23. It would ſeem neceſſary that the extremities of e nerves ſhould continue in this ſoft flexible ſtate, 21. 22.), in order to perform their functions right: ɔr, in proportion as parts become rigid and firm by ːe, or any other cauſe, they loſe of their ſenſibility, ıd the motions are more difficultly performed.

24. Though the fibres in a nervous cord are firmconnected, and frequently different nerves join inone trunk, or into the ſame *ganglion*; yet the ſenːion of each part of the body is ſo very diſtinct, ːd we have ſo much the power of moving the muſːs ſeparately, that, if the nerves are principal ants in theſe two functions, which I ſhall endeavour ı prove they are, we have reaſon to believe that there

is no union, confuſion, or immediate communicati of the proper nervous fibrils, but that each fibre r mains diſtinct from its origin to its termination.

25. Changes produced any way upon the coats the nerves, cannot however miſs to affect the nervo fibrils. The cellular ſubſtance may be too full of quor, or may not ſupply enough; the liquor may n be of a due conſiſtence, or it may be preternatural obſtructed and collected. The *pia* or *dura mate* may be too tenſe, or too lax; their veſſels may be o ſtructed; their proper nerves may be violently irrit ed, or loſe their power of acting; and a great ma other ſuch changes may happen, which will not on occaſion diſorders in particular nerves, but may be cauſe of the *ſympathy* ſo frequently obſerved amo the nerves; which is ſo neceſſary to be attentively r garded in a great many diſeaſes, in order to diſcov their true ſtate and nature, that, without this kno ledge, very dangerous miſtakes in the practice phyſic and ſurgery may be committed.

26. Many experiments and obſervations concur proving, that when nerves are compreſſed, cut, any other way deſtroyed, the parts ſerved by ſu nerves, farther from the head or ſpine than where t injuring cauſe has been applied, have their ſenſatio motions, and nouriſhment weakened or loſt, while ſuch effects are ſeen in the parts nearer to the orig of thoſe nerves; and in ſuch experiments where t cauſe impeding the nerves to exert themſelves co be removed, and the ſtructure of the nerves not i jured, as for example, when a ligature made upon nerve, and ſtopping its influence, has been taken aw the motion and ſenſation of the parts ſoon were ſtored. From which it would appear, that the ner are principal inſtruments in our ſenſations, motio and nouriſhment; and that this influence of t nerves is not inherent in them, without the co munication between theſe cords and their origin preſerved.

T

This conclusion is just, notwithstanding that some-imes, upon cutting a nerve, the effects above men-ioned have been felt for a short time; but afterwards he person was sensible of no numbness or immobili-y; for where-ever this is said to have happened, the ut nerve was only one of several which were sent to he member; the want of whose influence was felt o longer, than till the habit was acquired of per-orming the functions easily by the other nerves.

Nor is it of greater weight as an objection, that ometimes when a ligature is drawn very hard upon nerve, and then is taken away, the nerve never a-ain recovers its influence upon the parts it is distribut-d to beyond the ligature, but is of as little effect as it had been cut through; which is to say, that its exture has been altered beyond recovery. The same ning is to be seen by tying a thread tight round a ender twig of any vegetable; it decays.

27. Experiments and observations shew too, that hen parts of the *encephalon* or *spinal marrow* have een irritated, compressed, or destroyed, the parts of ie body, whose nerves had their origin from such ffected parts of the *encephalon* or *spinal marrow*, be-ome convulsed, paralytic, insensible, or wasted; and such cases where the injuring cause could be re-oved from the origin of the nerves, the morbid ymptoms observed in the parts to which these nerves ere distributed, went off upon the removal of that ause. From which it is thought reasonable to con-lude, that the nerves must not only have a com-unication with their origin, but that the influence ey have upon the parts they are distributed to, de-ends on the influence which they derive from the *edulla encephali* and *spinalis*.

28. Though the *spinal marrow* has its own vessels nd cineritious substance which assists to form its *me-ulla*; yet a very large share of the medullary sub-ance within the spine is derived from the *encephalon*, hose *medulla oblongata* descends from the head, and he influence of the *spinal marrow* on its nerves de-

 pends

pends in a great meaſure on this *medulla oblongata* o the head. Hence an injury done to any part of th *ſpinal marrow*, immediately affects all the parts whoſ nerves have their origin below where the injuring cauſe is applied. A luxation of a *vertebra* in the loin makes the lower extremities ſoon paralytic; a tranſverſe ſection of the *medulla* at the firſt *vertebra* of th neck, ſoon puts an end to life.

29. If ſuch cauſes produce conſtantly ſuch effect (§ 26. 27. 28) in us and other creatures living in nearly the ſame circumſtances as we do, the concluſions already made muſt be good, notwithſtanding examples of children and other creatures being born without *brains* or *ſpinal marrow*; or notwithſtanding that the brains of adult creatures can be much changed in their texture by diſeaſes; and that *tortoiſes*, and ſome other animals, continue to move a conſiderabl time after their heads are cut off. We may be ignorant of the particular circumſtances requiſite or neceſſary to the being or well-being of this or that particular creature, and we may be unable to accoun for a great many *phænomena*; but we muſt believ our eyes in the examination of facts; and if we ſe conſtantly ſuch conſequences from ſuch actions, w cannot but conclude the one to be the cauſe, and th other the effect. It would be as unjuſt to deny th concluſions made in the three preceding articles, be cauſe of the ſeemingly preternatural phænomena mentioned at the beginning of this, as it would b to deny the neceſſity of the circulation of the bloo in us and moſt quadrupeds, becauſe a frog can jump about, or a tortoiſe can walk long after all the bowel of its thorax and abdomen are taken out, or becauſ the different parts of a worm crawl after it has bee cut into a great many pieces. It is therefore almoſ univerſally allowed, that the nerves are *principal* inſtruments in our ſenſations, motion, and nouriſhment; and that the influence which they have is com municated from their origin, the *encephalon* and *me dulla ſpinalis*. But authors are far from agreeing a

bou

bout the manner in which this influence is communicated, or in what way nerves act to produce these effects.

30. Some alledge, that the *nervous fibres are all solid cords acting by elasticity or vibration;* others maintain, that *those fibres are small pipes conveying liquors, by means of which their effects are produced.*

31. The gentlemen, who think the nervous fibres solid, raise several objections to the other doctrine; which I shall consider afterwards; and endeavour to o shew the fitness of their own doctrine to account for the effects commonly observed to be produced by the nerves.

The objects of the senses plainly (say they) make impulses on the nerves of the proper organs, which must shake the nervous fibrils: and this vibration must be propagated along the whole cord to its other extremity or origin; as happens in other tense strings; and these vibrations being differently modified, according to the difference of the object, and its different application, produce the different ideas we have of objects.

32. To this account of sensation, it is objected, *first*, That nerves are unfit for vibrations, because their extremities, where objects are applied to them, are quite soft and pappy (§ 21.), and therefore not susceptible of the vibrations supposed; and if there could be any little tremor made here by the impulse of objects, it could not be continued along the nervous cord, because the cellular substance by which each particular fibre is connected to the neighbouring ones (§ 11.), and the fatty substance in which the nervous cord is immersed (§ 15.), would soon stifle any such vibratory motion.

A *second* objection to this doctrine is, that supposing the nerves capable of vibrations by the impressions of objects, these vibrations would not answer the design. For if what we know of other vibrating strings, to wit, that their tone remains the same, unless their texture, length, or tension is altered, and that diffe-

rent ſubſtances ſtriking them do no more than make the ſound higher or lower; if theſe properties are to be applied to nerves, then it will follow, that the ſame nerve would conſtantly convey the ſame idea, with no other variety than of its being weaker and ſtronger, whatever different objects were applied to it; unleſs we ſuppoſed the nerve changed in its texture, length, or tenſion, each time a different object is applied; which, it is preſumed, no body will undertake to prove does happen.

Nay, 3*dly*, If ever ſuch a variety of vibrations could be made, our ſenſations would notwithſtanding be confuſed and indiſtinct, becauſe the tremulous nervous fibre being firmly connected and contiguous to ſeveral other fibres of the ſame cord, would neceſſarily ſhake them too, by which we ſhould have the notion of the object as applied at all the different parts where the extremities of theſe fibres terminate.

33. In whatever way the favourers of the doctrine of ſolid nerves pleaſe to apply the elaſticity of nerves to the contraction of muſcles, their adverſaries inſiſt that nerves are too weak to reſiſt ſuch weights as the muſcles ſuſtain; they would ſurely break, eſpecially as they are in a great meaſure, if not wholly, deprived of their ſtrong coats before they come to the part of the muſcle they are immediately to act upon (§ 22.)—The nerves being found to have little or no elaſticity to ſhorten themſelves (§ 14.), ſhews them altogether unfit for ſuch an office as this of contracting muſcles in the way propoſed of their acting by elaſticity; and when a nerve is viewed with a microſcope while the muſcles it ſerves are in action, no contraction or motion is obſerved in it.—Nay, if they were elaſtic, they would equally exert their power of contracting muſcles nearer to their origin as well as farther from it, when they were put into contraction or vibration, by irritation of any part of them. The former however does not happen.

34. As a farther objection againſt either motion or ſenſation being owing to the elaſticity of the nerves

is ſaid, that if this doctrine was true, the ſenſaions would be more acute, and the contractions of muſcles would be greater and ſtronger, when the parts ecome firmer and more rigid by age; for then their laſticity is increaſed: Whereas, on the contrary, it ppears (§ 23.) that then the ſenſations are blunted, nd muſcular contraction becomes leſs and weaker.

35. If the nerves were granted to be elaſtic, and communicate a ſpringy force to all the parts they re diſtributed to, they might appear neceſſary in this iew to aſſiſt the application of the nutritious particles of the fluids to the ſides of the veſſels which theſe articles were to repair; and ſo far might well enough ccount for the ſhare which nerves are thought to ave in nutrition: But if we cannot make uſe of elaſticity in the other two functions, ſenſation and motion, we muſt alſo endeavour to find out ſome other vay for the nerves to act in nutrition; which will e done afterwards.

36. Having thus ſtated the reaſons for and againſt he nerves acting as ſolid ſtrings, let us likewiſe relate the arguments for nerves being pipes, and the bjections to this doctrine.

A great argument of thoſe who think the nerves to e tubes conveying liquors, is the ſtrong analogy of the rain and nerves to other glands of the body and their xcretories, where a manifeſt ſecretion of liquor is nade in the glands, to be conveyed by the excretoies to the proper places in which it ought to be depoſited: They think that the vaſcular texture of the *ortex* of the *encephalon* and *ſpinal marrow* (§ 2.), the ontinuation of the *cortex* in forming the medullary ubſtance (§ 3. 4.), the fibrous texture (§ 6.), and ucculent ſtate of this *medulla* (§ 5.), and its being vholly employed to form the nerves (§ 7.), where the ibrous texture is evident (§ 9.); all theſe things, ſay hey, conſpire to ſhew ſuch a ſtrong analogy between heſe parts and the other glands of the body, as caries a conviction that there is a liquor ſecreted in the

encephalon

encephalon and *ſpinal marrow*, to be ſent out by th nerves to the different parts of the body.

37. The following objections are raiſed to this ar gument in favour of liquor conveyed in the nerves from the analogy of the glands. *1ſt*, Other glands it is ſaid, have their excretories collected into a fev large pipes, and not continued in ſuch a great num ber of ſeparate pipes, as far as the places where th liquors are depoſited; which laſt muſt be the caſe, i the nerves are the excretories of the glandular brain *2dly*, We ſee the cavities, and can examine the li quors in the excretories of other glands much ſmalle than the brain; which cannot be done in the nerves *3dly*, If the nerves were pipes, they would be ſo ſmall, that the attraction of the liquors to their ſides would prevent that celerity in the motion of the li quors, which is requiſite to ſenſations and motions *4thly*, If the nerves were pipes, they would be cylin drical ones, and conſequently not ſubject to diſeaſes or at leaſt we could have no comprehenſion of th diſeaſes in them.

38. The anſwer to the *1ſt* of theſe objections is That there are other glands where there is a ma nifeſt ſecretion, and in which the diſpoſition of th excretories is in much the ſame way as is in the *ence phalon*: The kidneys, for example, have a reticulate *cortex* of veſſels, from which the *Euſtachian* or *Belli nian medulla*, conſiſting of longitudinal fibres and a few blood-veſſels in the ſame direction, proceeds; and this *medulla* is collected into ten, twelve, or more *papillæ*, each of which is formed of numerous ſmall ſeparate pipes, which ſingly diſcharge the urine into the large membranous tubes; and theſe united form the *pelvis*. Upon comparing this texture of the kid neys with that of the *encephalon* (§ 2. 3. 4. 5. 6. 7. 9.) the analogy will be found very ſtrong.

39. In anſwer to the *2d* objection, in § 37. it is granted, that microſcopes, injections, and all the other arts hitherto employed, have not ſhewn the cavities of the nervous fibrils, or the liquors contained in

n them; and from what was faid (§ 10.) of the ſmallneſs of the nervous fibrils, it is not to be expected that ever they ſhould be ſeen. But ſo long as ſuch a number of little animals can every hour be brought to the objectors, in which they can as little demonſtrate the veſſels or contained fluids, it will not be allowed to be concluſive reaſoning, that becauſe ocular demonſtration cannot be given of either the tubes or their contents, therefore they do not exiſt. For if we have any notion of an animal, it is its being an hydraulic machine, which has liquors moving in it as long as it has life; if therefore ſuch little animals have veſſels and liquors which we cannot ſee, why may not ſome of the veſſels and liquors of the human body be alſo inviſible to us?

To avoid this anſwer to the objection, it is further urged, That though we might not ſee the nervous tubes or the liquors they contain, as they naturally flow; yet if ſuch liquors really exiſt, they ought to diſcover themſelves, either by a nerve's ſwelling when it is firmly tied; or that, however ſubtile their fluids are, they might be collected in ſome drops, at leaſt, when the cut end of a nerve of a living animal is kept ſome time in the exhauſted receiver of an air-pump. It is affirmed, that neither did the tied nerve ſwell between the brain and ligature, nor was there any liquor collected in the receiver of the air-pump; from which it is concluded, that there is no liquor in the nerves.

Some, who ſay they have tried theſe experiments, affirm, that, in young animals, the nerve does ſwell above the ligature, and that a liquor does drill out upon cutting a nerve.—Whether ſwelling or liquor is ſeen or is not ſeen in theſe experiments, no concluſion for or againſt a nervous fluid can be made from them; for the ſwelling of the nerve after it is tied, or the efflux of liquors from its extremity, will never prove either to be the effect of the fluid in the proper nervous fibrils, ſo long as they might be occaſioned by the liquors in the larger veſſels of the cellular

cellular ſubſtance of the nerves; and if theſe ſame veſſels of the coats of the nerves do not diſcover their liquors by theſe experiments, it is far leſs to be expected, that the much more ſubtile nerves will diſcover theirs.

40. The 3*d* objection to the doctrine of the brain being a gland, and the nerves its excretories, ſuppoſes a more rapid motion neceſſary in the fluid of the nerves, than what moſt of the defenders of the nervous fluid will now allow; and is afterwards to be conſidered particularly in a more proper place.

41. The 4*th* objection being, That if nerves are excretories of a gland, they muſt be cylindrical pipes, in which no obſtructions or diſeaſes would happen; but ſince we daily ſee diſeaſes in the nerves, they muſt therefore not be ſuch excretories. The anſwer is, That diſeaſes happen often in the excretories of other glands, as of the liver, kidneys, *&c.* notwithſtanding their cylindrical form, and their much ſhorter and leſs expoſed courſe. When we conſider the very tender ſubſtance of the brain, the vaſt complication of veſſels there, the prodigious ſmallneſs of the pipes going out from it, the many moving powers which the nerves are to undergo the ſhock of, and the many chances which the veſſels, membranes, and cellular ſubſtance accompanying the nerves have of being diſordered, and then affecting the nervous fibrils, we have very great reaſon to be ſurpriſed, that theſe cylindrical pipes are not much more frequently put out of order, by too great or too ſmall a quantity of liquors; by two viſcid or too thin fluids; by liquors conſiſting of too mild and ſluggiſh particles or of too acrid pungent ones; by too great or too little motion given to the liquors; by the diameters of the pipes being too much ſtraitened, or too much enlarged; and by a great many other varieties of circumſtances which might be thought capable of diſturbing the functions of the nerves, ſuppoſing them to be cylindrical excretories of the gland, the brain

42. Th

42. The numerous veſſels of the *encephalon* have brought ſome of the gentlemen who aſſert the nerves to be ſolid, to acknowledge, that there is a liquor ſecreted in the brain: But then they will not allow that this liquor is ſent out by the proper nervous fibrils; but that it is poured into the cellular ſubſtance in which the nerves lie, to keep them moiſt and ſupple, and therefore fit for exerting their elaſticity, vibration, *&c.* by which, in their opinion, the effects commonly aſcribed to nerves are produced.

43. Beſides the objections already mentioned (§ 32. 33.) againſt the nerves acting as elaſtic ſtrings, this opinion has ſome other difficulties which may be objected to it: For inſtance, there is not one analogous example in the whole body of liquors ſecreted in a large gland, to be poured into a cellular ſubſtance, as is here ſuppoſed; the liquors in the cells of the *tela cellularis* of other parts are ſeparated from the little arteries which are diſtributed to theſe cells.

Further, it cannot be imagined, how a liquor ſecreted in the *cortex* of the brain ſhould make its way through the *medulla*, to come out into the cellular membranes on the ſurface of that *medulla*.

Laſtly, A very ſimple experiment, of injecting water by the artery of any member, and thereby filling the cellular ſubſtance of the nerves of that member, ſhews evidently, that the liquor of the *cellular* ſubſtance of the nerves has the ſame fountain as the liquor has in the *tela cellularis* any where elſe, that is, from the little arteries diſperſed upon it.

44. The doctrine of a fluid in the nerves, is not only thus ſupported by the analogy of the brain and nerves to the other glands and their excretories, but thoſe who maintain this doctrine mention an experiment which they think directly proves a fluid in the nerves. It is this: After opening the thorax of a living dog, catch hold of and preſs one or both the *phrenic* nerves with the fingers, the *diaphragm* immediately ceaſes to contract; ceaſe to compreſs the nerves, and the muſcle acts again: A ſecond time, lay

lay hold of the nerve or nerves ſome way above the *diaphragm*, its motion ſtops. Keep firm the hold of the nerve, and, with the fingers of the other hand, ſtrip it down from the fingers which make the compreſſion towards the *diaphragm*, and it again contracts: A repetition of this part of the experiment three or four times, is always attended with the ſame effects; but it then contracts no more, ſtrip as you will, unleſs you remove the preſſure, to take hold of the nerves above the place firſt pinched; when the muſcle may again be made to contract, by ſtripping the nerve down towards it. This experiment I have done with the ſucceſs here mentioned. Let any one try if he can imagine any other reaſonable account of theſe appearances, than that the preſſure by the fingers ſtopped the courſe of a fluid in the nerve; that ſo much of this fluid as remained in the nerve, betwixt the fingers and *diaphragm* was forced into that muſcle by ſtripping, and when it was all preſſed away, the fingers above preventing a ſupply, the muſcle contracted no more till the fingers were removed, and a freſh flow by that means was received from the ſpinal marrow, or from that part of the nerve which had yet not been ſo ſtripped.

It has been objected to the concluſions from this experiment, 1. That the *diaphragm* is ſet in motion by ſtripping the nerve from, as well as towards this muſcle; and this may be well expected; for a liquor in ſuch ſmall pipes hindered to flow backwards by ligature, pinching fingers, or even the flow of their liquors from the fountain, will regurgitate forwards with velocity, when preſſed backwards. We ſee it happen in the ſtalks of tender ſucculent plants.

2. It is ſaid, that muſcles ceaſe to act when their veins are tied, as well as when their arteries or nerves are tied or cut, but that muſcles continue to act when their veins are cut; by which it would appear, that the overloading of the veſſels is an impediment to the action of muſcles, and therefore the ceaſing of their action,

ction, when their arteries or nerves are tied or cut, may alſo be owing to the liquor in the branches of theſe pipes of muſcles ſtagnating when it is not propelled by the flow of more liquor from their trunks, and not to any influence or moving power, which now ceaſes to be conveyed to them.

It is to be obſerved in making the experiments juſt now mentioned, that the contraction of the muſcles ceaſes ſooneſt when the nerves, and lateſt when the veins are tied.—-That when veins are tied, not only are the veſſels overloaded, but all the cellular ſubſtance of the muſcles is filled with coagulated blood; whereas when the arteries and nerves are tied, the reverſe is ſeen, the muſcles are lax and of leſs bulk. So that in theſe caſes, the ceaſing of the contraction of the muſcles ſeems to depend on very different cauſes, to wit, a deprivation of neceſſary liquors in the one, and a redundancy of ſuperfluous blood in the other. An elaſtic ſtick may be deprived of its elaſticity by being made either too dry or too wet.

§ 45. Some gentlemen, convinced of the reaſonableneſs of the ſecretion of a liquor in the brain to be ſent out by the nerves, but not comprehending how a fluid could have ſuch a rapid retrograde motion as they imagined was neceſſary for conveying the impreſſions of objects made on the extremities of nerves to the *ſenſorium*, ſuppoſed two ſorts of nerves; one that conveyed a liquor for muſcular motion and nutrition; the other compoſed of ſolid nerves, that were to ſerve for organs of the ſenſes, to convey the vibrations communicated from objects to the *ſenſorium*.

§ 46. To this opinion (§ 45.) the objections againſt the ſenſatory nerves acting by vibration (§ 32.) may be made; and there is ſo little reaſon to ſuſpect any difference in the texture of the different parts of the brain or nerves, that, on the contrary, the ſtructure is every where ſimilar, and branches of the ſame nerve often ſerve both for ſenſation and motion.

How little neceſſity there is for ſuppoſing extreme-ly rapid motions of the nervous fluid, is to be exa-mined ſoon.

47. The hypotheſis of great celerity in the motio of the fluid of the nerves being neceſſary, gave al riſe to another diviſion of the nerves, into *arterio* or *effluent*, and *venous* or *refluent*. It was ſaid, th muſcular motion and nutrition depended on the arte-rious nerves; and that the ſenſations depended on a accelerated motion of the nervous fluid towards tl brain, by the impreſſions which the objects of tl ſenſes make upon the venous nerves. By this ſuppoſi-tion the abſurdity of rapid fluxes and refluxes in tl ſame canal was prevented, and an advantage w thought to be gained by it, of ſaving too great waſte of the fluid of the nerves, which otherwiſe tl *encephalon* and *ſpinal marrow* could not ſupply in ſu ficient quantity to anſwer all the exigencies of life.

48. To this opinion (§ 47.) it has been objecte 1*ſt*, That there is no example in the body, of a ſ creted liquor being returned immediately and unmi ed to the gland by which it was originally ſeparat from the maſs of blood; which would be the ca were there venous nerves. 2*dly*, There is no occaſi for ſaving the fluid of the nerves in the way propo ed; the organs for ſecreting that fluid being large nough to ſupply all that is neceſſary of it in the com mon functions of life.——3*dly*, If the fluid of t nerves was to be thus kept in a perpetual circulatio it would ſoon become too acrid for continuing wi ſafety in ſuch ſenſible tender veſſels as the brain a nerves are compoſed of. 4*thly*, This hypotheſis w not anſwer the deſign for which it was propoſe For though the momentary application of an obje might cauſe an acceleration in the fluid of veno nerves, yet if the object was kept applied to t nerves, it would ſtop their fluid, ſo that it could n go forward to the brain; and therefore, according this doctrine, we ſhould be ſenſible of no objec

xcept thofe whofe application to the organs of the ſenſes was momentary.

49. Let us now ſuppoſe it probable, that the *encephalon* and *ſpinal marrow* ſecern a liquor from the blood which is ſent into all the nerves, and that by the means of this liquor, the nerves perform the offices commonly aſſigned to them; it is next neceſſary to enquire what kind of liquor this is, and how it moves, in order to determine how well its nature and motion are fitted for performing what is expected from it.

50. The liquor of the nerves has been fancied by ſome to be of a very ſtrong acid or alcaline nature: But ſince none of our juices appear to be of this ſort, and ſince ſuch liquors irritate and deſtroy the parts of the body which they are applied to, we cannot conceive how the brain can ſeparate, or the nerves could bear any thing of ſuch an acrid nature. This tenderneſs and ſenſibility of theſe organs muſt hinder us abſolutely from ſuppoſing that the liquor of the nerves can be acrid or pungent, or of the nature of ſpirit of wine, hartſhorn, *&c.*

51. Some have imagined the liquor of the nerves to be capable of vaſt exploſion like gun-powder, or of violent ſudden rarefaction like air, or of ſtrong ebullition like boiling water, or the mixture of acids with alcaline liquors. But as the maſs of blood from which this fluid is derived, is not poſſeſſed of any ſuch properties, we cannot ſuppoſe the blood to furniſh what it has not in itſelf. Beſides, all theſe operations are too violent for the brain or nerves to bear; and when once they are begun, they are not ſo quickly controlled or reſtrained, as experience teaches us the nerves can be made to ceaſe from acting.

52. We are not ſufficiently acquainted with the properties of an *æther* or *electrical effluvia* pervading every thing, to apply them juſtly in the animal œconomy; and it is as difficult to conceive how they ſhould be retained or conducted in a long nervous cord. Theſe are difficulties not to be ſurmounted.

53. The fureft way of judging what kind of liquo this of the nerves muft be, is to examine the liquor of fimilar parts of the body. All the glands feparate liquors from the blood much thinner than the compound mafs itfelf; fuch is the *liquor* poured into the cavity of the *abdomen*, *thorax*, *ventricles of the brain*, the *faliva*, *pancreatic juice*, *lymph*, &c. Wherever there is occafion for fecreted liquors being thick and vifcid, in order to anfwer better the ufes they are intended for, nature has provided refervoirs for them to ftagnate in, where their thinner parts may be carried off by the numerous abforbent veins difperfed on the fides of thofe cavities; or they may exhale where they are expofed to the open air. The *mucus of the nofe* becomes vifcid by ftagnation; for, when it is immediately fecreted it is thin and watery; as appears from the application of fternutatories, *&c.* The *cerumen* of the ears is of a watery confiftence, when juft fqueezing out. The *mucus* of the alimentary canal grows thick in the *lacunæ*. The *bile* in the hepatic duct has little more confiftence than *lymph;* that in the gall-bladder is vifcid and ftrong. The *urine* is much more watery as it flows from the kidneys, than when it is excreted from the bladder. The *feed* is thin as it comes from the tefticles, and is concocted in the *veficulæ feminales*, *&c.*

54. Hence (§ 53.) we may fafely conclude, that a thin liquor is fecreted in the *cortex encephali* and *fpinal marrow;* and feeing the thinnefs of fecreted liquors is generally, as the divifions of the veffels, into fmall fubtile branches, and that the ramifications within the fcull are almoft infinitely fubtile, the liquor fecreted in the *encephalon* may be determined to be among the fineft or thinneft fluids.

55. Seeing alfo that we can obferve no large refervoir, where the liquor fecerned in the *cortical fubftance* is depofited, to have its finer parts taken off, we have reafon to think, that it goes forward into the nerves in the fame condition in which it is fecerned.

56. By

56. By fine or ſubtile animal liquors, is meant no more than thoſe which are very fluid, and which ſeem to conſiſt of a large proportion of watery particles, and a leſſer one of the oily, ſaline, and terreſtrious particles. Some of the liquors which we can have in ſufficient quantity to make experiments with, are ſo fluid, and have ſo little viſcidity or cohesion of parts, that when laid upon a piece of clean mirror, they evaporate without leaving a ſtain; ſuch is the liquor oozing out from the ſurface of the *pleura*, the lymph, and ſeveral others.

If then theſe liquors, which are ſubject to our examination, the ſecerning veſſels of which are ſo large that we can ſee them, have ſuch a ſmall coheſion of parts, it might not be unreaſonable to ſay, that the liquor of the nerves is as much more fine and fluid than lymph, as the veſſels ſeparating it are ſmaller; and therefore that the fluid of the nerves is a defecated water, with a very ſmall proportion of the other principles extremely ſubtilized.

57. Two experiments are ſaid to contradict this opinion, of the liquor of the nerves being ſo fluid and ſubtile. One is, that upon cutting the *cauda equina* of a living animal, a liquor as viſcid as the white of an egg drops out: The other is, that a wounded nerve yields a *glairy ſanies*. But theſe do not appear to be the proper fluid of the nerves; ſince it is evident, that what is diſcharged in both theſe caſes, comes out of the cellular ſubſtance involving the nervous fibrils.

58. Conſidering how many experiments make it evident, that there is a conſtant uninterrupted ſtream of liquors flowing through all the canals of animals, which convey liquors compoſed of particles ſmaller than the diameter of their canal, which is always the caſe of the nerves in a natural ſtate; it is ſupriſing how it ever could be thought that the liquid of the nerves ſhould be obliged to flow from the brain to each muſcle the moment we will; or that this liquor ſhould flow back with the like ſwiftneſs from

the extremity of each nerve, to which an object of fenfation is applied. The nerves, as well as the other excretories of the glands, always are full of liquor; the degree of diftenfion of the canals not being at all times alike even in a found ftate. But this happens without inconvenience, as the fides of the canals have a power to accommodate themfelves to the prefent quantity, unlefs it is very much above or below the natural ftandard; in both which cafes difeafes enfue.

59. The motion of the fluid in the nerves is therefore not only conftant, but it is alfo equal, or nearly fo: For, though the blood in the larger arteries is moved unequally, by the unequal forces, the contraction of the ventricle of the heart, and the weaker power, the *fyftole* of the arteries; yet the difference between thefe two moving powers comes to be lefs and lefs perceptible, as the arteries divide into fmaller branches; becaufe of the numerous refiftances which the liquors meet with, and becaufe the canals they move in become larger, till in the very fmall arterious branches, there is no fenfible difference in the velocity of the liquors from the effect of the heart or arteries. The motion of the fluids muft ftill be more equal in the excretories of glands, and particularly in thofe where the veffels have divided into very minute branches, and the liquors have no other propelling force but the heart and arteries, (fee § 1.); therefore the nervous fluid moves conftantly, equally, and flowly, unlefs when its courfe is altered by the influence of the mind, or by the preffure of fome neighbouring active organ.

60. As there is neither proof nor probability of the *valves* fuppofed by fome in nerves, we are not to affume them in accounting for any *phænomena*.

61. We have not, and perhaps cannot have any idea of the manner in which mind and body act upon each other; but if we allow that the one is affected by the other, which none deny, and that the fluid of the nerves (whatever name people pleafe to

give

ive it) is a principal inſtrument which the mind nakes uſe of to influence the actions of the body, or o inform itſelf of the impreſſions made on the body, re muſt allow that the mind can direct this inſtrument differently, particularly as to quantity and celerity, though we muſt remain ignorant of the manner how many *phænomena* depending on this connection of mind and body are produced. Thus we vould in vain attempt to account for animals contiuing, after their heads were ſtruck off, or their hearts vere cut out, to perform actions begun before they uffered any injury.

62. Let us now ſuppoſe the nervous fluid ſuch as as been argued for, to wit, a very fluid ſaponaceous vater, moving in a conſtant, equal, ſlow ſtream, from ne *encephalon* and *ſpinal marrow*, in each of the proer nervous fibres, except when the motion is chaned by ſome acceſſory cauſe, ſuch as the mind, preſure of other parts, &c.; and let us examine how vell ſuch a ſuppoſition will agree with the *phænomena* f the three great functions, nutrition, ſenſation, and nuſcular motion, which the nerves are principal inruments of.

63. In general, we may ſay, that nerves can carry uids to the moſt minute part of the body, to ſupply vhat is waſted in any of the ſolids; that the impreſon made by the objects of the ſenſes on the very oft pulpy extremities of the nerves of the organs of ne ſenſes, muſt make ſuch a ſtop in the equal-flowing ervous fluid, as muſt inſtantaneouſly be perceptible : the fountain head from which the pipes affected riſe; that the conſtant flow of the liquor of the erves into the cavities of the *muſcular fibrillæ*, occaons the natural contraction of the muſcles, by the s conſtant *niſus* it makes to increaſe the tranſverſe, nd to ſhorten the longitudinal diameter of each fibre; nd that it is only to allow the mind a power of deermining a greater quantity of this ſame fluid with a reater velocity into what muſcular fibres it pleaſes,

to

to account for the voluntary ſtrong action of the muſcles.

64. But ſince ſuch a ſuperficial account would not be ſatisfactory, it will be expected, that the principal *phænomena* of theſe three functions ſhould be explained by the means of ſuch a fluid as has been ſuppoſed; and that the ſeveral objections againſt this doctrine ſhould be anſwered: Let us attempt this; and where we cannot extricate ourſelves from difficulties which may be thrown in, let us honeſtly acknowledge ignorance.

65. *α*. If water, with a very ſmall proportion of oils and ſalts from the earth, proves a fit nouriſhment for vegetables, ſuch a liquor as the fluid of the nerves has been deſcribed (§ 56.) may not be unfit for repairing the waſte in animals.

β. The ſlow continual motion of this nervous fluid (§ 58. 59.) to the moſt minute parts of the body (§ 10.), is well enough calculated to ſupply the particles that are conſtantly worn off from the ſolids by the circulation of the liquors and neceſſary actions of life.

γ. The greater proportional ſize of the *encephalon* in young creatures than in adults, ſeems calculated for their greater proportional growth: For the younger the animal is, the larger *encephalon* and ſpeedier growth it has.

δ. A palſy and atrophy of the members generally accompanying each other, ſhew, that nouriſhment, ſenſation, and motion, depend on the ſame cauſe.

ε. It was ſaid (§ 26.), that the nerves were *principal* inſtruments in nutrition: It was not affirmed, that they were the *ſole* inſtruments; and therefore an *atrophy* may proceed from the compreſſion or other leſion of an artery, without being an objection to the doctrine here laid down.

66. *a*. All objects of ſenſe, when applied to their proper organs, act by impulſe; and this action is capable of being increaſed by increaſing the impelling force. In tangible objects, that is clearly evident; the

he clofer they are preffed to a certain degree, the nore diftinct perception enfues. Odorous particles ιeed the affiftance of air moved rapidly, to affect our ofe: Sapid fubftances, that are fcarce fufficient to 'ive us an idea of their tafte by their own weight, are ffifted by the preffure of the tongue upon the palate: 'he rays of light collected drive light bodies before ıem : Sound communicates a vibration to all bodies ı harmonic proportion with it.

The impulfes made thus by any of thefe objects on ıe foft pulpy nerves (§ 21.), which are full of liuor, preffes their fides or extremities, and their liıor is hindered to flow fo freely as it did. The caıls being all full (§ 58.) this refiftance muft inftanneoufly affect the whole column of fluids in the caıls that are preffed, and their origins, and have the me effect as if the impulfe had been made upon the igin itfelf. To illuftrate this by a grofs comparin : Let any one pufh water out of a fyringe, through long flexible pipe fixed to the fyringe, and he is ıfible of refiftance or a pufh backwards, the moent any one ftops the orifice of the pipe, or clofes ı: fides of it with his fingers. This impulfe made ‹ the nerves, and thus communicated to their ori‹ı, varies according to the ftrength or weaknefs, ı: quicknefs or flownefs, the continuance or fpeedy ınoval, the uniformity or irregularity, the conftan‹ or alternation, &c. with which objects are applied t the nerves.

ƅ. Whenever any object is regularly applied with ‹e force to a nerve, rightly difpofed to be impreffed l it, and is communicated, as juft now explained, t the *fenforium*, it gives a true and juft idea of the ‹ ect to the mind.

:. The various kinds of impulfes which the differıt claffes of objects make, occafion in animals, ‹ ich ought to have accurate perceptions of each o ect, a neceffity of having the different organs of tl fenfes varioufly modified, fo that the feveral imp fes may be regularly applied to the nerves in each organ ;

organ; or, in other words, we muſt have different organs of the ſenſes fitted to the different claſſes of objects.

d. As the objects have one common property of impulſe, ſo all the organs have moſt of the properties of the organ of touching in common with the *papillæ* of the ſkin. In the noſe and tongue, this is evident: In ſome operations of the eyes we can alſo perceive this; as we may likewiſe do in ſome caſes where matter is collected in the internal ear.

e. Theſe properties common to the different objects and organs, occaſion frequently uncommon effects in the application of an object to an organ proper to another object of ſenſation; for ſometimes we have the ſame idea as if the object had been applied to its own proper organ: At other times the object is as it were changed, and we have the idea as if the organ had had its own proper object applied to it. Thus, for example, light is the proper object to be applied to the eye, to give us any idea of colours; yet when all light is excluded from the eyes, an idea of light and colours may be excited in us by coughing, ſneezing, rubbing, or ſtriking the eye-ball.—A cane vibrating, ſo as not to excite ſound perceptible to the ear, applied to the teeth, raiſes a ſtrong idea of ſound as a little inſect creeping in the *meatus auditorius* also does.—The fingers applied to two rough ſurfaces rubbing on each other, are ſenſible of the ſound they make; ſurgeons of any practice in the cure of fractured bones can bear witneſs to the truth of this.—The fingers dipped in acid and ſeveral other acrid liquors, have a ſenſation very like to taſting.—Smelling and taſting, every body knows, are ſubſervient and aſſiſting to each other. From ſuch examples we have further proof of one general cauſe of our ſenſations, to wit, impulſe from the objects; and of ſuch a ſimilarity and relation in the organs as might give reaſon for imagining that any one of them would be capable of producing the effect of another, if the impulſes of the different objects could be regularly ap-

plied to each.—Hence light and ſound may affect inſects and other animals that have not eyes or ears.

f. If the impulſe of an object is applied with due force, but irregularly, a confuſed idea of the object is raiſed. Diſtant objects are confuſed to *myopes*, as very near ones are to *preſbytæ*.

g. If the application of the impulſe is regular, but the force with which it is applied is too weak, our perception of the object is too faint. One may whiſper ſo low as not to be heard.

h. If the application of objects is too violent, and there is any danger of the tender organs of our ſenſes being hurt or deſtroyed, an uneaſy ſenſation we call *pain* is raiſed, whatever the organ thus injured is. The object of feeling affects every organ: Thus preſſure, ſtretching, cutting, pricking, acrid ſalts, pungent oils, great heat, violent cold, *&c.* occaſion pain, where-ever they are applied. Beſides, every particular organ can be affected with pain by the too violent application of its own proper object. Too much light pains the eyes; very loud ſounds ſtuns the ears; very odorous bodies and too ſapid objects hurt the noſe and tongue. A pretty ſure proof this, that the objects of our ſenſes all act, and that the organs are all impreſſed, in nearly the ſame way.

i. Since a middle impulſe, neither too ſmall nor too great, is neceſſary for a clear perception of objects, we would often be in danger of not diſtinguiſhing them, if we were not ſubjected to another law, to wit, that numerous impulſes made at once, or in a quick ſucceſſion to each other, increaſe our perceptions of objects. Thus, ſuch ſound as would not be heard on a mountain top, will be diſtinctly heard in a wainſcotted-chamber.—We feel much more clearly a tangible object when our finger is drawn alongſt it, than when applied with the ſame force, but by a ſingle preſſure, upon it —We make repeated applications of odorous and ſapid objects, when we wiſh to ſmell or taſte accurately.—The end of a burning ſtick appears

appears much more luminous when quickly whirled in a circle than when at reſt.

k. Whenever the uneaſy ſenſation, *pain*, is raiſed by the too ſtrong application of objects, a ſort of neceſſity is as it were impoſed upon the mind to endeavour to get free of the injuring cauſe, by either withdrawing the grieved part of the body from it, as one retires his hand when his finger is pricked or burnt; or the injuring cauſe is endeavoured to be forced from the body, as a *teneſmus* excites the contraction which puſhes acrid *fœces* out of the *rectum*. In both theſe operations, a convulſive contraction is immediately made in the leſed part, or in the neighbourhood of it; and if the irritation is very ſtrong or permanent, the greater part of the nervous ſyſtem becomes affected in that ſpaſmodic or convulſive way.—Is it this neceſſity which obliges the mind to exert herſelf in reſpiration, or in the action of the heart, when the lungs or heart are gorged with blood? or the *iris* to contract the pupil, when the eye is expoſed to ſtrong light? or ſneezing to be performed when the noſe is tickled? &c.—Will not a *ſtimulus* of any nerve more readily affect thoſe with which it is any where connected than the other nerves of the body?—May not this ſympathy ſerve as a monitor of the mind rather to employ the organs furniſhed with nerves thus connected, to aſſiſt in freeing her of any uneaſy ſenſation, than to make uſe of any other organs?—Will not this in ſome meaſure account for many ſalutary operations performed in the body, before experience has taught us the functions of the organs performing them?

This *niſus* of the mind to free the body of what is in danger of being hurtful, may ſerve to explain the *phænomena* of a great many diſeaſes, when we are acquainted with the diſtribution of the particular nerves; and from this we can underſtand the operation of medicines that ſtimulate; and may learn how, by exciting a ſharp, but momentary pain, we may free the body of another pain that would be more durable; and

nd that, by having it thus in our power to determine flow of the liquor of the nerves to any particular part, for the benefit of that part, or the relief of any ther diseased part, we can do considerable service by right application of the proper medicines.

l. If a pain-giving cause is very violent or long ontinued, it destroys the organs either irrecoverably; r puts them so much out of order that they only radually recover: People have been made blind or eaf for all their lives after a violent effect of light n their eyes, or of sound on their ears; and we are equently exposed to as much light and sound as to ake us unfit to see or hear for a considerable time. would explain this by a ligature put round the tener branch of an herb. This ligature drawn to a ertain degree, may weaken the canals so as to be un- for the circulation of the juices a good while, till ey are gradually explicated and made firm by these ices: A stricter ligature would disorder the struc- re of the fibres so much, that the liquors could not cover them. The analogy is so plain, that it needs commentary.—Thus, the influence of a nerve tied ith an artery in the operation of an aneurism, may ase for some time, but be afterwards recovered.

67. 1. In applying the fluid of the nerves to the tion of muscles, it was said, that the natural or voluntary contraction of muscles was the *nisus* which e nervous fluid flowing constantly into the muscu- fibres makes to distend these fibrils, by enlarging eir transverse diameters and shortening their axes; d that voluntary contraction was owing to a greater antity of that nervous liquor determined towards e muscle to be put in action, and poured with eater *momentum* into the muscular fibrils, by the wer of the mind willing to make such a muscle to a, or obliged to do it by an irritating pain-giving cise (§ 66. *k.*)

2. Some object to this account of muscular motion, tht if there is no outlet for the liquor supposed to b poured into muscular fibres, muscles would always

be in a ſtate of contraction, which they are not; an
if there is a paſſage from the fibrils, the liquor woul
flow out as faſt as it was thrown in; and therefor
no diſtenſion of the fibres or contraction of the muſ
cles could be made.

3. In anſwer to this objection, it is obſerved, tha
notwithſtanding the evident outlet from the arteri
into the veins, yet the arteries are diſtended by th
ſyſtole of the heart, or any other cauſe increaſing th
momentum of the blood.

4. It has been alſo objected to § 1. That, if it wa
true, the volume of the muſcle in contraction neceſ
ſarily would be conſiderably increaſed by ſo much li
quor poured into its fibrils; whereas it does not ap
pear, by any experiment, that the volume of a muſ
cle is increaſed by its being put into action.

5. To this it has been anſwered, 1. That when th
axes of muſcular fibres are ſhortened, and their tranſ
verſe diameters are enlarged, the capacities of the
fibres, and conſequently their volume, may not b
changed, the diminution one way balancing the in
creaſe in the other. 2. That the ſpaces between th
muſcular fibres are ſufficient to lodge theſe fibres whe
they ſwell, during the contraction of a muſcle, with
out any addition to its bulk; and that it plainly ap
pears that theſe ſpaces between the fibrils are thus oc
cupied, by the compreſſion which the larger veſſels o
muſcles, which run in thoſe ſpaces, ſuffer during th
action of the muſcle; it is ſo great as to drive th
blood in the veins with a remarkable accelerated ve
locity.

6. Another objection to the action of muſcles be
ing owing to the influx of a fluid into their fibrils, i
That muſcular fibres are diſtractile, or capable of b
ing ſtretched; and therefore, when a fluid is pour
into their hollow fibrils, they would be ſtretched lo
gitudinally, as well as have their tranſverſe diamete
increaſed; that is, a muſcle would become longe
as well as thicker, when it is put into action; wher

s it is certainly known, that a mufcle is fhortened 'hile it acts.

7. In anfwer to this, it has been remarked, That ıough mufcular fibrils are diftractile, yet they will ot yield to, or be ftretched by every force, however nall, that might be applied to them. A cord that ın be ftretched in length by the weight of a pound r two, would not yield in the leaft to an ounce or vo; and it muft likewife be obferved, that graduall as any body is ftretched, its refiftance to the retching force increafes. A rope may be ftretched) a certain length by a pound weight appended to , which would require two pounds to ftretch it very ttle further; and therefore, the general obfervation f animal fibres being diftractile, cannot be a reanable objection to the account of mufcular motion ove-mentioned, unlefs a proof is brought that the rce which the liquid of the nerves muft exert upon ıch fibre of a mufcle, in order to make it act, is ıpable of diftracting or ftretching the fibres; which ıs not yet been attempted to be proved.—It would ppear, from the pain caufed by too great an effort of ıufcles, efpecially in weak people, that mufcular bres can bear very little diftraction without danger f a folution of continuity.

8. Mufcles ceafing to act when their arteries are ed or cut, and being brought into motion by injectıg liquors into the arteries even of a dead animal, ıs been mentioned as objections to the nervous inıence caufing their contractions.

To the firft of thefe experiments it may be anfwerl, That the tying or cutting of the nerves, fooner oduces the effect of making the contraction ceafe, ıan ftopping the influx of the arterious blood does; ıd it will be univerfally allowed, that the influx of ood into mufcles is neceffary for performing their ınctions right.

Whoever obferves the motion which injecting war, or any other liquor into the arteries of a dead aimal, caufes in its mufcles, will not compare it to

A a 2 what

what contraction, whether voluntary or excited by irritation, he may see in a living one.

9. If muscular motion depends on the influx of the nervous liquid, the instantaneous contraction of a muscle, when the mind wills to make it act, will be easily understood from the nerves being always full of their liquor (§ 58. 66. *a.*)

10. If either the nerves of any muscle do not furnish a sufficient quantity of their liquor, or if the fibres of a muscle become too easily distractile, such a muscle will be inactive or paralytic.

11. If too great a quantity of the liquor of the nerves is determined to a muscle or muscles, by any cause which the mind cannot command, such muscle or muscles will be convulsed.

12. If the motion of the liquid of the nerves is not uniform, but by disease becomes irregular, an alternate relaxation and contraction of muscles may be the consequence. Hence trembling palsies, *chorea Sancti Viti*, &c. Hence also the convulsive tremors which animals have when they lose much blood.

13. Though the nerves may not furnish so much liquor as may be sufficient to make muscles contract with strength enough to overcome the resistances to their actions, yet there may be a sufficient quantity of liquor in the nerves to allow the impressions of objects to be conveyed to the *sensorium*. This may be one cause of a member's being sometimes sensible after it cannot be moved.

14. Unless the liquor of the nerves acquires some energy in the brain, which we have no reason to think the circulation of the fluids in the vessels can give it, or unless it has other properties than what we can discover in it, or unless there is an agent regulating its *momentum* and course to different parts which we are not conscious of; if some of these, I say, do not obtain, the action of the heart continuing of equal force to propel our liquors, notwithstanding all the resistances that are to it, is not to be explained

15. Al

15. All mufcles, but efpecially the heart, continue to contract in an irregular way, after they are cut away from the animal to whom they belonged; which may be owing to the liquors continuing to flow in the fmall veffels, and being poured irregularly into the mufcular *fibrillæ*.

16. It is faid that a mufcle cut out of the body continues fome time to be capable of contraction; whereas, by tying its arteries or nerves, while it is otherwife entire in the body, it lofes its contracting power, which therefore does not depend on thefe organs, the arteries or nerves.

The lofs of the power of acting, when the arteries or nerves are tied while the mufcle is in the body, is denied by fome who made the trial; and it might be expected, that the motion of a mufcle would be more confpicuous where there is no refiftance to it, as is the cafe when it is cut away from all the parts it is connected with, than when its connection remains with parts refifting its contractile efforts.

17. After the heart, or any other mufcle cut away from an animal, has ceafed to contract, its contraction may again be reftored, by breathing upon it, or pricking it with any fharp inftrument. That heat or pricking fhould, by their *ftimulus* (§ 66. *k.*), occafion contraction in a living creature, may be underftood; but how they fhould have the fame effect in a mufcle feparated from an animal, I know not.

68. Some have thought the *ganglions* of nerves (§ 18, 19, 20.) to be glandular, and to perform a fecretion.—Others, from their firm texture, fuppofe them to be mufcular, and to ferve to accelerate the motion of the liquor in the nerves which proceed from them; but as no proof is offered of either of thefe opinions, they cannot be maintained.—Others would make them ferve, 1. To divide a fmall nerve into many nerves, and by thefe means to increafe the number of nervous branches. 2. To make nerves come conveniently by different directions to the parts to which they belong. 3. To reunite feveral fmall

nervous fibres into one large nerve.—Since no proof is brought that theſe three things cannot be done without the interpoſition of a *ganglion*, but, on the contrary, we ſee them performed where there are no *ganglions*, we muſt continue to acknowledge ignorance concerning the uſes of theſe knots, the *ganglions*.

Of the PARTICULAR NERVES.

'TIS generally ſaid, that there are forty pair of nerves in all; of which ten come out from the *encephalon*, and the other thirty have their origin from the *ſpinal marrow*.

Of the ten pair of nerves which come from the *encephalon*, the firſt is the *OLFACTORY*, which long had the name of the *mammillary proceſſes* of the brain, becauſe in the brutes, cows and ſheep, which were moſt commonly diſſected by the ancients, the anterior ventricles of the brain are extended forwards upon theſe nerves, and adhere ſo firmly to them, that they ſeem to make the upper ſide of the nerves. Each of them being large, where it begins to be ſtretched out, and gradually becoming ſmaller as it approaches the cribriform bone, was imagined to reſemble a nipple. Thoſe who miſtook the ventricles for part of the nerves, obſerving the cavity in them full of liquor, concluded, that theſe olfactory nerves ſerved to convey the ſuperfluous moiſture of the brain to the holes of the ethmoid bone through which it paſſed into the noſe. But in man, the ventricles of whoſe brain are not thus extended forwards, theſe nerves are ſmall, long, and without any cavity, having their origin from the *corpora ſtriata*, near the part where the internal carotid arteries are about to ſend off their branches to the different parts of the brain; and in their courſe under the anterior lobes of the brain, which have each a depreſſion made for

lodging

odging them, the human olfactory nerves become larger, till they are extended to the cribriform bone; where they split into a great number of small filaments, to pass through the little holes in that bone; and, being joined by a branch of the fifth pair of nerves, are spread on the membrane of the nose.

The tender structure and sudden expansion of these nerves on such a large surface, render it impossible to trace them far; which has made some authors deny them to be nerves: But when we break the circumference of the *cribriform lamella*, and then gently raise it, we may see the distribution of the nerves some way on the membrane of the nose.

The contrivance of defending these long soft nerves from being too much pressed by the anterior lobes of the brain under which they lie, is singular; because they have not only the prominent orbitar processes of the frontal bone to support the brain on each side, with the veins going into the longitudinal *sinus*, and other attachments bearing it up, but there is a groove formed in each lobe of the brain itself for them to lodge in.—Their splitting into so many small branches before they enter the bones of the skull, is likewise peculiar to them; for, generally, the nerves come from the brain in disgregated filaments, and unite into cords, as they are going out at the holes of the bones. This contrivance is the best for answering the purpose they are designed for, of being the organ of smelling; for, had they been expanded upon the membrane of the nose into a medullary web, such as the optic nerve forms, it would have been too sensible to bear the impressions of such objects as are applied to the nose; and a distribution in the more common way, of a cord sending off branches, would not have been equal enough for such an organ of sensation.

The 2*d* pair of nerves, the *OPTIC*, rising from the *thalami nervorum opticorum*, make a large curve outwards, and then run obliquely inwards and forwards, till they unite at the fore-part of the *sella Turcica*;

cica; then foon divide, and each runs obliquely forwards and outwards, to go out at its proper hole in the fphenoid bone, accompanied with the ocular artery, to be extended to the globe of the eye, within which each is expanded into a very fine cup-like web, that lines all the infide of the eye as far forwards as the *ciliary circle*, and is univerfally known by the name of *retina*.

Though the fubftance of this pair of nerves feems to be blended at the place where they are joined, yet obfervations of people whofe optic nerves were not joined, and of others who were blind of one eye from a fault in the optic nerve, or in thofe who had one of their eyes taken out, make it appear, that there is no fuch intimate union of fubftance; the optic nerve of the affected fide only being wafted, while the other was large and plump. And the fame obfervations are contradictory to the doctrine of a decuffation of all the nerves (§ 8.); for the difeafe could be traced from the affected eye to the origin of the nerve on the fame fide. In many fifhes, indeed, the doctrine of decuffation is favoured; for their optic nerves plainly crofs each other, without any union at the part where they are joined in men and moft quadrupeds.

Thefe people whofe optic nerves were not joined, having neither feen objects double, nor turned their eyes different ways, is alfo a plain proof, that the conjunction of the optic nerves will not ferve to account for either the uniform motions of our eyes, or our feeing objects fingle with two eyes, though it may be one caufe of the remarkable fympathy of the one eye with the other in many difeafes.

The *retina* of a recent eye, without any preparation, appears a very fine web, with fome blood veffels coming from its centre to be diftributed on it; but after a good injection of the arteries that run in the fubftance of this nerve, as is common to other nerves, it is with difficulty that we can obferve its nervous medullary fubftance.—The fituation of thefe veffe-

veſſels in the central part of the optic nerve; the want of medullary fibres here, and the firmneſs of this nerve before it is expanded at its entry into the ball of the eye, may be the reaſon why we do not ſee ſuch bodies, or parts of bodies, whoſe picture falls on this central part of the *retina*. An inflammation in thoſe arteries of the *retina*, which ſeveral fevers and an *ophthalmia* are generally attended with, may very well account for the tenderneſs in the eyes, and inability to bear the light, which people have in theſe diſeaſes.—The over-diſtenſion of theſe veſſels may likewiſe ſerve to account for the black ſpots obſerved on bright coloured bodies eſpecially, and for that ſmoaky fog through which all objects are ſeen by people in ſome fevers.—If theſe veſſels loſe their tone, and remain preternaturally diſtended, no objects affect our *retina*, though the eye externally appears ſound; or this may be one cauſe of an *amauroſis* or *gutta ſerena*.—From a partial diſtenſion of theſe veſſels, or *paralyſis* of a part of the *retina*, the central part, or the circumference, or any other part of objects, may be loſt to one or both eyes.

The *THIRD PAIR* riſe from the anterior part of the *proceſſus annularis*, and, piercing the *dura mater* a little before, and to a ſide of the ends of the poſterior clinoid proceſs of the ſphenoid bone, run along the *receptacula*, or *cavernous ſinuſes*, at the ſide of the *ephippium*, to get out at the *foramina lacera*; after which, each of them divides into branches, of which one, after forming a little *ganglion*, is diſtributed to the globe of the eye; the others are ſent to the *muſculus rectus* of the *palpebra*, and to the *attollens*, *adductor*, *deprimens*, and *obliquus minor* muſcles of the eye-ball. Theſe muſcles being principal inſtruments in the motions of the eye-lid and eye-ball, this nerve has therefore got the name of the *motor oculi*.—I have frequently obſerved in convulſions the eye-lids widely opened, the *cornea* turned upward and outwards, and the eye-balls ſunk in the orbit; which well deſcribed the conjunct action of the muſcles which

which this pair of nerves ſerves.—The diſtenſion of a conſiderable branch of the carotid, which paſſes over this nerve near its origin on each ſide, may poſſibly be the reaſon of the heavineſs in the eye-lids and eyes, after drinking hard, or eating much.

The *FOURTH PAIR*, which are the ſmalleſt nerves of any, derive their origin from the back-part of the baſe of the *teſtes;* and then making a long courſe on the ſide of the annular protuberance, enter the *dura mater* a little farther back, and more externally than the third part, to run alſo along the *receptacula*, to paſs out at the *foramina lacera*, and to be entirely ſpent on the *muſculi trochleares*, or ſuperior oblique muſcles of the eyes. Theſe muſcles being employed in performing the rotatory motions, and the advancement of the eye-balls forward, by which ſeveral of our paſſions are expreſſed, the nerves that ſerve them have got the name of *PATHETICI.*—Why theſe ſmall nerves ſhould be brought ſo far to this muſcle, when it could have been ſupplied eaſily by the *motor oculi*, I know not.

The *FIFTH PAIR* are large nerves, riſing from the annular proceſſes where the medullary proceſſes of the *cerebellum* join in the formation of that *tuber*, to enter the *dura mater* near the point of the petrous proceſs of the temporal bones; and then ſinking cloſe by the *receptacula* at the ſides of the *ſella Turcia*, each becomes in appearance thicker, and goes out of the ſkull in three great branches.

The firſt branch of the fifth is the *OPHTHALMIC*, which runs through the *foramen lacerum* to the orbit, having in its paſſage thither a connection with the ſixth pair. It is afterwards diſtributed to the ball of the eye with the third, to the noſe, along with the olfactory, which the branch of the fifth that paſſes through the *foramen orbitarium internum* joins, as was already mentioned in the deſcription of the firſt pair. This ophthalmic branch likewiſe ſupplies the parts at the internal *canthus* of the orbit, the *glandula lacrymalis*, fat, membranes, muſcles, and teguments

guments of the eye-lids; its longeſt fartheſt extended branch paſſing through the *foramen ſuperciliare* of the *os frontis*, to be diſtributed to the forehead.

The ſmall fibres which this firſt branch of the fifth and the third pair of nerves ſend to the eye-ball, being ſituated on the optic nerve, and, after piercing the ſclerotic coat, running along the choroid coat on the outſide of the *retina* in their courſe to the *uvea* or *iris*, may be a cauſe of the ſympathy between the optic nerve and the *uvea;* by which we more readily acquire the habit of contracting the *iris*, and thereby leſſen the pupil, when too ſtrong light is excluded; and, on the contrary, enlarge the pupil, when the light is too faint.—This, with the ſympathy which muſt ariſe from ſome of the nerves of the membrane of the noſtrils, being derived from this firſt branch of the fifth pair of nerves, may alſo be the cauſe, why an irritation of the *retina*, by too ſtrong light, may produce ſneezing, as if a *ſtimulus* had been applied to the membrane of the noſe itſelf;—why preſſing the internal *canthus* of the orbit, ſometimes ſtops ſneezing;—why irritation of the noſe or of the eye cauſes the eye-lids to ſhut convulſively, and makes the tears to flow plentifully; and why medicines put into the noſe, do often great ſervice in diſeaſes of the eyes.—In the megrim, all the branches of the nerve diſcover themſelves to be affected: For the forehead is racked with pain, the eye-ball is pained, and feels as if it was ſqueezed, the eye-lids ſhut convulſively, the tears trickle down, and an uneaſy heat is felt in the noſe. Hence we can underſtand where external medicines will have the beſt effect, when applied to remove this diſeaſe, to wit, to the membrane of the noſe, and to the forehead;—why alternate preſſure near the ſuperciliary hole of the frontal bone, or ſneezing, ſometimes gives immediate relief in the megrim;—why the ſight may be loſt by an injury done to the *ſupraorbitar* branch;—how it may be reſtored by agitation of that branch of this nerve.

The

The ſecond branch of the fifth pair of nerves may be called *MAXILLARIS SUPERIOR*, from its ſerving principally the parts of the upper jaw. It goes out at the round hole of the ſphenoid bone, and ſends immediately one branch into the channel on the top of the *antrum maxillare;* the membrane of which and the upper teeth are ſupplied by it in its paſſage. As this branch is about to go out at the *foramen orbitarium externum*, it ſends a nerve through the ſubſtance of the *os maxillare* to come out at *Steno*'s duct, to be diſtributed to the fore-part of the palate; and what remains of it eſcaping at the *external orbitar* hole, divides into a great many branches, that ſupply the cheek, upper lip, and noſtril.—The next conſiderable branch of the *ſuperior maxillary* nerve, after giving branches which are reflected through the ſixth hole of the *ſphenoid* bone, to join the intercoſtal where it is paſſing through the ſkull with the carotid artery, and the *portio dura* of the ſeventh pair, as it paſſes through the *os petroſum*, is ſent into the noſe by the hole common to the palate and ſphenoidal bone; and the remaining part of this nerve runs in the *palato-maxillaris* canal, giving off branches to the temples and pterygoid muſcles, and comes at laſt into the palate to be loſt.—Hence, the ach in the teeth of the upper jaw occaſions a gnawing pain, deep-ſeated in the bones of the face, with ſwelling in the eye-lids, cheek, noſe, and upper lip; and, on the other hand, an inflammation in theſe parts, or a megrim, is often attended with ſharp pain in the teeth.—Hence, an obſtruction in the duct of the maxillary ſinus, which obliges the liquor ſecreted there to find out a preternatural route for itſelf, may be occaſioned by the pain of the teeth.—Hence, the upper lip often ſuffers when the palate or noſe is ulcerated.

The third or *MAXILLARIS INFERIOR* branch of the fifth pair going out at the oval hole of the ſphenoid bone, ſerves the muſcles of the lower jaw, and the muſcles ſituated between the *os hyoides* and

jaw:

aw: All the salivary glands, the *amygdalæ*, and the xternal ear, have branches from it: It has a large ranch loſt in the tongue, and ſends another through he canal in the ſubſtance of the lower jaw to ſerve ll the teeth there, and to come out at the hole in he fore-part of the jaw, to be loſt in the chin and nder-lip.—Hence, a convulſive contraction of the nuſcles of the lower jaw, or the mouth's being in-oluntarily ſhut, a great flow of ſpittle or ſalivation, pain in the ear, eſpecially in deglutition, and a welling all about the throat, are natural conſequen-es of a violent irritation of the nerves of the lower eeth in the tooth-ach; and pain in the teeth and ar, is as natural a conſequence of an *angina*.—Hence, lternate preſſure on the chin may ſometimes relieve he violence of a tooth-ach.—Hence, deſtroying the erves of a tooth by actual or potential cauteries, or ulling a carious tooth, ſo often removes immediate-y all theſe ſymptoms.—Hence, no cure is to be ound for ſome ulcers in the upper or lower jaw, but y drawing a tooth.—Hence, in cancers of the up-er lip, the ſalivary glands are in danger of being af-ected, or the diſeaſe may be occaſioned to the lip by ts beginning in the glands.—Perhaps the ſympathy f the organs of taſting and ſmelling may, in ſome neaſure, depend on their both receiving nerves from he fifth pair.

The *SIXTH PAIR*, which is the ſmalleſt except he fourth, riſes from the fore-part of the *corpora py-amidalia;* and each entering the *dura mater* ſome vay behind the poſterior clinoid proceſs of the ſphe-oid bone, has a long courſe below that membrane, nd within the *receptaculum* at the ſide of the *ſella Turcica*, where it is immerſed in the blood of the re-eptacle; but for what purpoſe I am ignorant. It oes afterwards out at the *foramen lacerum* into the rbit, to ſerve the abductor muſcle of the eye.—A efect in this nerve may therefore be one cauſe of a *ſtrabiſmus*.—In the paſſage of this nerve below the *dura mater*, it lies very contiguous to the internal ca-

 rotid

rotid artery, and to the ophthalmic branch of the fifth pair of nerves. At the place where the fixth pair is contiguous to the carotid, a nerve either goes from each of them in an uncommon way, to wit, with the angle beyond where it rifes obtufe, to defcend with the artery, and to form the beginning of the intercoftal nerve, according to the common defcription; or, according to other authors, this nerve comes up from the great *ganglion* of the *intercoftal*, to be joined to the fixth here.

The arguments for this latter opinion are, That, according to the common doctrine, this beginning of the *intercoftal* nerve, as it is called, would rife in a manner not fo ordinary in nerves. In the next place, it is obferved, that the fixth pair is larger nearer to the orbit, than it is before it comes to the place where this nerve is faid to go off; and therefore, it is more probable, that it receives an addition there, rather than gives off a branch. *Laftly*, It is found, that upon cutting the *intercoftal* nerves of living animals, the eyes plainly were affected; they loft their bright water; the gum, or gore, as we call it, was feparated in greater quantity; the pupil was more contracted; the cartilaginous membrane, at the internal *canthus*, came more over the eye; and the eyeball itfelf was diminifhed.

To this it is anfwered, in defence of the more common doctrine, 1*ft*, That other branches of nerves go off in a reflected way, as well as this does, fuppofing it to be the beginning of the intercoftal; and that the reflection would rather be greater, if it is thought to come up from the intercoftal to the fixth. 2*dly*, It is denied that this nerve is for ordinary thicker at its fore than its back part; and if it was fuppofed to be thickeft nearer to the orbit, the conclufion made above could not be drawn from this appearance, becaufe other nerves enlarge fometimes where there is no addition made to them, as in the inftance already mentioned of the trunk of the fifth pair while below the *dura mater*. 3*dly*, The experiments on living

ving animals ſhew indeed, that the eyes are affect-
d, upon cutting the intercoſtal nerve, but not in the
ay which might have been expected, if the *inter-
ſtal* had furniſhed ſuch a ſhare of the nerve that
oes to the *adductor* muſcle of the eye; for it might
ave been thought, that this muſcle would have been
much weakened immediately upon cutting the *in-
rcoſtal*, that its antagoniſt the *adductor* would have
reatly prevailed over it, and have turned the eye
rongly in towards the noſe; which is not ſaid to be
conſequence of this experiment. So that the argu-
ents are ſtill equivocal; and more obſervations and
xperiments muſt be made, before it can be deter-
ined with certainty, whether the ſixth pair gives or
ceives a branch here. In the mean time, I ſhall
ontinue to ſpeak about the origin of the *intercoſtal*
ith the generality of anatomiſts.

At this place where the intercoſtal begins, the fifth
air is contiguous and adherent to the ſixth; and it
generally ſaid, that the ophthalmic branch of the
fth gives a branch or two to the beginning of the
tercoſtal, or receives ſuch from it. Others deny
ny ſuch communication between them; and thoſe
ho affirm the communication confeſs, that in ſome
ibjects they could not ſee it. After examining the
erves here in a great many ſubjects, I cannot deter-
ine whether or not there are nervous filaments
oing from the one to the other. Sometimes I have
hought that I traced them evidently; at other times I
bſerved, that what I diſſected for nervous filaments
vas collapſed cellular ſubſtance; and in all the ſub-
ects where I had puſhed an injection ſucceſsfully in-
the very ſmall arteries, I could only obſerve a *plex-
s* of veſſels connecting the one to the other. In any
f theſe ways, however, there is as much connection
s, we are aſſured from many experiments and ob-
ervations on other nerves, is ſufficient to make a very
reat ſympathy among the nerves here. Poſſibly the
ppearances in the eyes of dogs, whoſe intercoſtal
erves were cut, might be owing to this ſympathy.

The *SEVENTH PAIR* comes out from the lateral part of the *annular procefs*, behind where the medullary procefs of the *cerebellum* are joined to that *tuber;* and each being accompanied with a larger artery than moft other nerves, enters the *internal meatus auditorius*, where the two large bundles of fibres, of which it appeared to confift within the fcull, foon feparate from each other; one of them entering by feveral fmall holes into the *veftible*, *cochlea*, and *femicircular canals*, is ftretched on this inner *camera* of the ear in a very foft pulpy fubftance; and being never feen in the form of a firm cord, fuch as the other parcel of this and moft other nerves become, is called *PORTIO MOLLIS* of the auditory nerve.

The other part of this feventh pair paffes through *Galen's foramen cæcum*, or *Fallopius's aquæduct*, in its crooked paffage by the fide of the *tympanum;* in which paffage, a nerve fent from the lingual branch of the inferior maxillary nerve, along the outfide of the *tuba Euftachiana*, and crofs the cavity of the *tympanum*, where it has the name of *chorda tympani* is commonly faid to be joined to it. The very acute angle which this nerve makes with the fifth, or the fudden violent reflection it would fuffer on the fuppofition of its coming from the fifth to the feventh appears unufual; whereas, if we fuppofe that it comes from the feventh to the fifth, its courfe would be more in the ordinary way, and the *chorda tympani* would be efteemed a branch of the feventh pair going to join the fifth, the fize of which is increafed by this acquifition. This fmaller bundle of the feventh gives branches to the mufcles of the *malleus*, and to the *dura mater*, while it paffes through the bony crooked canal, and at laft comes out in a firm chord named *PORTIO DURA*, at the end of this canal between the *ftyloid* and *maftoid* proceffes of the temporal bone, giving immediately filaments to the little oblique mufcles of the head and to thofe that rife from the ftyloid procefs. It then pierces through the parotid gland, and divides into a great many branches which

which are difperfed in the mufcles and teguments that cover all the fide of the upper part of the neck, the whole face and *cranium*, as far back as the temples, including a confiderable part of the external ear. Its branches having thus a confiderable connection with all the three branches of the fifth pair, and with the fecond cervical, occafion a confiderable fympathy of thefe nerves with it.—Hence in the tooth-ach, the pain is fometimes very little in the affected tooth, compared to what it is all along the fide of the head, and in the ear.—Hence probably the relief of the tooth-ach from blifters applied behind or before the ear, or by a hot iron touching the *antihelix* of the ear.—By this communication or connection poffibly too it is, that a vibrating ftring held between one's teeth, gives a ftrong idea of found to the perfon who holds it, which nobody elfe can perceive.—Perhaps too the diftribution of this nerve occafions the head to be fo quickly turned upon the impreffion of found on our ears.

The *EIGHTH PAIR* of nerves rife from the lateral bafes of the *corpora olivaria* in difgregated fibres; and as they are entering the anterior internal part of the holes common to the *os occipitis* and *temporum*, each is joined by a nerve which afcends within the *dura mater* from the tenth of the head, the firft, fecond and inferior cervical nerves: This every body knows has the name of the *NERVUS ACCESSORIUS*. When the two get out of the fcull, the *acceffiorius* feparates from the eighth, and, defcending obliquely outwards, paffes through the *fterno-maftoideus* mufcle, to which it gives branches, and afterwards terminates in the *trapezius* and *rhomboid* mufcles of the *fcapula*. In this courfe it is generally more or lefs joined by the fecond cervical nerve. Why this nerve, and feveral others which are diftributed to mufcles, are made to pierce through mufcles, which they might have only paffed near to, I do not know.

The large *eighth pair*, foon after its exit, gives nerves to the tongue, *larynx*, *pharynx*, and *ganglion*

 of

of the *intercostal* nerve, and being disjoined from the ninth and intercostal, to which it adheres closely some way, runs straight down the neck behind the internal jugular vein, and at the external side of the carotid artery. As it is about to enter the *thorax*, a large nerve goes off from the eighth of each side: This branch of the right-side turns round from the fore to the back-part of the subclavian artery, while the branch of the left-side turns round the great curve of the *aorta*, and both of them mounting up again at the side of the *œsophagus*, to which they give branches, are lost at last in the *larynx*. These are called the *RECURRENT* nerves, which we are desired to shun in the operation of *bronchotomy*, though their deep situation protects them sufficiently.—The muscles of the *larynx*, being in a good measure supplied with nerves from the recurrents, it is to be expected, that the cutting of them will greatly weaken the voice, though it will not be entirely lost, so long as the superior branches of the eighth pair are entire.—Why the recurrent nerves rise so low from the eighth pair to go round a large artery, and to have such a long course upwards, I know not.

The eighth pair, above and at or near the place where the recurrent nerves go off from it, or frequently the recurrents themselves, send off small nerves to the *pericardium*, and to join with the branches of the intercostal that are distributed to the heart; but their size and situation are uncertain.

After these branches are sent off, the *par vagum* on each side descends behind the great branch of the *trachea*, and gives numerous filaments to the lungs, and some to the heart in going to the *œsophagus*. The one of the left side running on the fore part of the *œsophagus*, communicates by several branches with the right one in its descent to be distributed to the stomach: The right one gets behind the *œsophagus*, where it splits and rejoins several times before it arrives at the stomach, to which it sends nerves; and then being joined by one or more branches from the left-

eſt-trunk, they run towards the cæliac artery, there o join into the great *ſemilunar ganglion* formed by the wo intercoſtals.

From the diſtribution of this *par vagum*, we may earn how tickling the *fauces* with a feather or any ſuch ubſtance, excites a *nauſea* and inclination to vomit;—vhy coughing occaſions vomiting, or vomiting raiſes a ough.—Hence we ſee how the nervous *aſthma* and he *tuſſis convulſiva*, chincough, are attended with a traitening of the *glottis*;—why food difficult to digeſt occaſions the *aſthma* to weakly people, and why *emeics* have frequently cured the *aſthma* very ſpeedily;—vhy an attempt to vomit is ſometimes in danger of uffocating *aſthmatic* people;—why the ſuperior oriice of the ſtomach is ſo ſenſible, as to be looked on s the ſeat of the ſoul by ſome;—why people ſubject o diſtenſions of the ſtomach, have ſo often the ſenation of balls in their breaſts and throats;—why the *lobus hyſtericus* is ſo often attended with a violent trangulation at the *glottis*.

The *NINTH PAIR* of nerves comes from the inerior part of the *corpora pyramidalia*, to go out of the cull at their proper holes of the occipital bone. After their egreſs they adhere for ſome way firmly to he eighth and intercoſtal; and then ſending a branch, hat in many ſubjects is joined with branches of the irſt and ſecond cervical nerves, to be diſtributed to he thyroid gland and muſcles on the fore-part of the *rachea arteria*, the ninth is loſt in the muſcles and ubſtance of the tongue. Some have thought this erve, and others have eſteemed the third branch of he fifth pair of nerves, to be the proper guſtatory erve. I know no obſervation or experiments to rove either opinion, or to aſſure us that both nerves o not ſerve for taſting and for the motion of the ongue.—May not the diſtribution of this nerve to ne muſcles below as well as above the *os hyoides*, ontribute to their acting more uniformly in depreſſng the lower jaw or head?

The

The *TENTH PAIR* rises in separate threads from the sides of the *spinal marrow*, to go out between the *os occipitis* and *first vertebra* of the neck. After each of them has given banches to the great ganglion of the intercostal, 8th, 9th, and 1st cervical nerves, it is distributed to the straight, oblique, and some of the extensor muscles of the head. Whether the name of the tenth of the head, or of the first vertebral, ought to be given to this pair of nerves, is of no such consequence as to deserve a debate, though it has some of the marks of the spinal nerves, to wit, its being formed of filaments proceeding from both the fore and back part of the *medulla*, and a little *ganglion* being formed where these filaments meet.

In the description of the sixth pair, I followed the usual way of speaking among anatomists, and called that the beginning of the intercostal nerve which comes out of the scull; and therefore shall here subjoin a cursory description of this nerve, notwithstanding its much larger part is composed of nerves coming out from the *spinal marrow*. There is no greater incongruity in point of method to say, that the nerve we are describing receives additions from others that have not been described, than it is to repeat in the description of a great many nerves, that each of them gives branches to form a nerve which we are ignorant of; which is all the difference between describing the intercostal before or after the spinal nerves.

The branch reflected from the sixth pair, joined possibly by some filaments of the *opththalmic* branch of the fifth, runs along with the internal carotid artery, through the crooked canal formed for it in the *temporal bone*, where the little nerve is very soft and pappy, and in several subjects divides and unites again, and is joined by one or more branches from the fifth, particularly of its superior maxillary branch before it comes out of the scull. May the compression of this nerve by the carotid artery when stretched during the *systole*, contribute to the *diastole* of the heart? As soon as the nerve escapes out of this bony canal,

canal, it is connected a little way with the eighth and ninth; then separating from these, after seeming to receive additional nerves from them, it forms a large *ganglion*, into which branches from the tenth of the head, and from the first and second cervical enter. From this ganglion the nerves come out again small to run down the neck along with the carotid artery, communicating by branches with the cervical nerves, and giving nerves to the muscles that bend the head and neck. As the *intercostal* is about to enter the *thorax*, it forms another ganglion, from which nerves are sent to the *trachea* and to the heart; these designed for the heart joining with the branches of the eighth, and most of them passing between the two great arteries and the auricles, to the substance of that muscle. The intercostal after this consisting of two branches, one going behind, and the other running over the fore-part of the subclavian artery, forms a new ganglion where the two branches unite below that artery, and then descending along the sides of the *vertebræ* of the *thorax*, receives branches from each of the dorsal nerves; which branches appearing to come out between the ribs, have given the name of intercostal to the whole nerve. Where the addition is made to it from the fifth dorsal nerve, a branch goes off obliquely forwards; which being joined by such branches from the sixth, seventh, eighth, and ninth dorsal, an anterior trunk is formed, and passes between the fibres of the *appendix musculosa*, of the diaphragm, to form, along with the other intercostal and the branches of the eighth pair, a large semilunar ganglion, situated between the cæliac and superior mesenteric arteries; the roots of which are as it were involved in a sort of nervous net-work of this ganglion, from which a great number of very small nervous threads run out to be extended on the surface of all the branches of those two arteries, so as to be easily seen when any of the arteries are stretched, but not to be raised from them by dissection: and thus the *liver*, *gall-bladder*, *duodenum*, *pancreas*, *spleen*, *jejunum*,

jejunum, *ilium*, and a large ſhare of the *colon*, have their nerves ſent from this great *ſolar ganglion* or *plexus*.—May the periſtaltic motion of the inteſtines depend in ſome meaſure on the paſſage of the intercoſtal nerves through the diaphragm?

Several fibres of this ganglion, running down upon the *aorta*, meet with other nerves ſent from the poſterior trunk of the intercoſtal, which continues its courſe along the ſides of the *vertebræ*; they ſupply the *glandulæ renales*, kidneys, and *teſtes* in men, or *ovaria* in women; and then they form a net-work upon the inferior meſenteric artery, where the nerves of the two ſides meet, and accompany the branches of this artery to the part of the *colon* that lies in the left ſide of the belly, and to the *rectum*, as far down as to the lower part of the *pelvis*.

The intercoſtal continuing down by the ſide of the *vertebræ* of the loins, is joined by nerves coming from between theſe *vertebræ*, and ſends nerves to the organs of generation and others in the *pelvis*, being even joined with thoſe that are ſent to the inferior extremities.

The almoſt univerſal connection and communication which this nerve has with the other nerves of the body, may lead us to underſtand the following, and a great many more *phænomena*:—Why tickling the noſe cauſes ſneezing.—Why the too great quantity of bile in the *cholera* occaſions vomiting as well as purging.—Why people vomit in colics, in inflammations, or other irritations of the liver, or of the ducts going from it and the gall-bladder.—Why a ſtone in the kidneys, or ureters, or any other cauſe irritating thoſe organs, ſhould ſo much more frequently bring on vomiting and other diſorders of the ſtomach, than the ſtone, or any other ſtimulating cauſe in the bladder does.—Why vomiting is a ſymptom of danger after child birth, lithotomy, and other operations on the parts in the *pelvis*.—Why the obſtructions of the *menſes* are capable of occaſioning ſtrangulations, belching, colics, ſtomach-aches, and even convulſions

convulsions in the extremities.—Why vesicatories, applied from the ears to the clavicles of children labouring under the *tussis convulsiva*, are frequently of great service.—Why worms in the stomach or guts excite an itching in the nose, or grinding of the teeth.—Why irritations in the bowels or the belly occasion sometimes universal convulsions of the body.

The *spinal* nerves rise generally by a number of disgregated fibres from both the fore and back-part of the *medulla spinalis*, and soon after form a little knot or ganglion, where they acquire strong coats, and are extended into firm cords. They are distinguished by numbers, according to the *vertebræ* from between which they come out; the superior of the two bones forming the hole through which they pass, being the one from which the number is applied to each nerve. There are generally said to be *thirty pair* of them; seven of which come out between the *vertebræ* of the neck, twelve between those of the *back*, five between those of the loins, and six from the *false vertebræ*.

The *FIRST CERVICAL* pair of nerves comes out between the first and second *vertebræ* of the neck; and having given branches to join with the tenth pair of the head, the second cervical and intercostal, and to serve the muscles that bend the neck, it sends its largest branches backwards to the extensor muscles of the head and neck; some of which piercing through these muscles, run up on the *occiput* to be lost in the teguments here; and many fibres of it advance so far forward as to be connected with the *fibrils* of the first branch of the fifth pair of the head, and of the *portio dura* of the *auditory nerve*.—Hence possibly it is that a *clavus hystericus* changes suddenly sometimes from the fore-head to a violent pain and spasm in the back-part of the head and neck.

The *SECOND CERVICAL* is soon joined by some branches to the ninth of the head and intercostal, and to the first and third of the neck; then has a large branch that comes out at the exterior edge of the *sterno-mastoideus* muscle, where it joins with the

accessorius

acceſſorius of the eighth pair; and is afterwards diſtributed to the *platyſma myoides*, teguments of the ſide of the neck and head, parotid gland, and external ear, being connected to the *portio dura* of the auditory nerve, and to the firſt cervical. The remainder of this ſecond cervical is ſpent on the *levator ſcapulæ* and the extenſors of the neck and head. Generally a large branch is here ſent off to join the *acceſſorius* of the eighth pair, near the ſuperior angle of the *ſcapula*.

To the irritation of the branches of this nerve it probably is, that, in an inflammation of the parotid gland, the neck is pained ſo far down as the clavicle, the head is drawn towards the ſhoulder of the affected ſide, and the chin is turned to the other ſide.—In opening the external jugular vein, no operator can promiſe not to touch ſome of the cutaneous branches of this nerve with the lancet; which occaſions a ſharp pricking pain in the mean time, and a numbneſs of the ſkin near the orifice for ſome time after.

The *THIRD PAIR* of the neck paſſes out between the third and fourth cervical *vertebræ*; having immediately a communication with the ſecond, and ſending down a branch, which being joined by a branch from the fourth cervical, forms the *PHRENIC* nerve. This deſcending enters the *thorax* between the ſubclavian vein and artery; and then being received into a groove formed for it in the *pericardium*, it has its courſe along this *capſula* of the heart, till it is loſt in the middle part of the diaphragm. The right phrenic has a ſtraight courſe; but the left one is obliged to make a conſiderable turn outwards to go over the prominent part of the *pericardium*, where the point of the heart is lodged. Hence in violent palpitations of the heart, a pungent acute pain is felt near the left orifice of the ſtomach.—The middle of the diaphragm ſcarce could have been ſupplied by any other nerve which could have had ſuch a ſtraight courſe as the *phrenic* has. If the ſubclavian artery

rtery and vein have any effect upon this nerve, I do ıot know it.

The other branches of the third cervical nerve are liſtributed to the muſcles and teguments at the lower ıart of the neck and top of the ſhoulder. No won- ler then that an inflammation of the liver or ſpleen, n abſceſs in the lungs adhering to the diaphragm, or ny other cauſe capable of irritating the diaphragm, hould be attended with a ſharp pain on the top of the houlder, as well as wounds, ulcers, &c. of this nuſcle itſelf.—If the irritation of this muſcle is very iolent, it may occaſion that convulſive contraction f the diaphragm which is called an *hiccough*; and herefore an hiccough in an inflammation of the liver as been juſtly declared to be an ill ſymptom.

An irritation of the thoracic nerves which produces neezing, may ſometimes free the phrenic nerves from ny ſpaſm they occaſion; ſo that ſneezing ſometimes akes away the hiccough; and a derivation of the uid of the nerves any other way may do the ſame hing: Or the hiccough may alſo be ſometimes cured, y drawing up into the noſe the ſmoak of burning aper or other acrid fumes, ſwallowing pungent or romatic medicines, and by a ſurpriſe, or any other rong application of the mind in thinking, or in diſ- inguiſhing objects: Or, when all theſe have failed, has been put away by the briſk *ſtimulus* of a bliſter- ıg plaſter applied to the back.

The *FOURTH CERVICAL* nerve, after ſending ff that branch which joins with the third to form he phrenic, and beſtowing twigs on the muſcles, and lands of the neck, runs to the arm-pit, where it ıeets with the *FIFTH*, *SIXTH*, and *SEVENTH* ervicals, and *FIRST DORSAL*, that eſcape in the ıterſtices of the *muſculi ſcaleni*, to come at the arm- it, where they join, ſeparate, and rejoin, in a way arce to be rightly expreſſed in words; and after giv- ıg ſeveral conſiderable nerves to the muſcles and te- ıments which cover the *thorax*, they divide into ſe- eral branches, to be diſtributed to all the parts of

the ſuperior extremity. Seven of theſe branches I ſhall deſcribe under particular names.

1. *SCAPULARIS* runs ſtraight to the *cavitas ſemilunata* of the upper *coſta* of the *ſcapula*, which is a hole in the recent ſubject by a ligament being extended from one angle of the bone to the other, giving nerves in its way to the muſcles of the *ſcapula*. When it has paſſed this hole, it ſupplies the *ſupra ſpinatus* muſcle; and then deſcending at the anterior root of the *ſpine* of the *ſcapula*, it is loſt in the other muſcles that lie on the *dorſum* of that bone.

2. *ARTICULARIS* ſinks downwards at the *axilla*, to get below the neck of the head of the *os humeri*, and to mount again at the back-part of it; ſo that it almoſt ſurrounds the articulation, and is diſtributed to the muſcles that draw the arm back, and to thoſe that raiſe it up.

3. *CUTANEUS* runs down the fore-part of the arm near the ſkin, to which it gives off branches; and then divides on the inſide of the fore-arm into ſeveral nerves, which ſupply the teguments there, and on the palm of the hand.—In opening the baſilic vein of the arm, at the ordinary place, the ſame ſymptoms are ſometimes produced as in opening the external jugular vein, and from a like cauſe, to wit, from hurting a branch of this cutaneous nerve with the lancet.

4. *MUSCULO-CUTANEUS*, or *perforans Caſſeri*, paſſes through the *coraco-brachialis* muſcle; and after ſupplying the *biceps flexor cubiti* and *brachiæus internus*, paſſes behind the tendon of the *biceps*, and over the cephalic vein, to be beſtowed on the teguments on the outſide of the fore-arm and back of the hand.—This nerve is ſometimes hurt in opening the cephalic vein, and cauſes pain and numbneſs for a ſhort time.

5. *MUSCULARIS* has a ſpiral courſe from the *axilla*, under the *os humeri*, and backward to the external part of that bone, ſupplying by the way the extenſor muſcles of the fore-arm, to which it runs between the two *brachiæi* muſcles, and within the

ſupinator

upinator radij longus.—At the upper part of the fore-arm, it ſends off a branch, which accompanies the *ſupinator longus* till it comes near the wriſt, where it paſſes obliquely over the *radius*, to be loſt in the back of the hand and fingers.—The principal part of this nerve pierces through the *ſupinator radii brevis*, to ſerve the muſcles that extend the hand and fingers, whoſe actions are not injured when the *ſupinator* acts.

6. *ULNARIS* is extended along the inſide of the arm, to give nerves to the muſcles that extend the fore-arm and to the teguments of the elbow: Towards the lower part of the arm, it ſlants a little backward to come at the groove behind the internal condyle of the *os humeri*, through which it runs to the *ulna*: In its courſe along this bone, it ſerves the neighbouring muſcles and teguments; and as it comes near the wriſt, it detaches a branch obliquely over the *ulna* to the back of the hand, to be loſt in the convex part of ſeveral fingers. The larger part of the nerve goes ſtraight forward to the internal ſide of the *os piſiforme* of the wriſt; where it ſends off a branch which ſinks under the large tendons in the palm, to go croſs to the other ſide of the wriſt, ſerving the *muſculi lumbricales* and *interoſſei*, and at laſt terminating in the ſhort muſcles of the thumb and fore-finger. What remains of the ulnar nerve, after ſupplying the ſhort muſcles of the little finger, divides into three branches; whereof two are extended along the ſides of the ſheath of the tendons of the flexors of the little finger, to furniſh the concave ſide of that finger; and the third branch is diſpoſed in the ſame way upon the ſide of the ring finger next to the little finger.

When we lean or preſs on the internal condyle of the *os humeri*, the numbneſs and prickling we frequently feel, point out the courſe of this nerve. I have ſeen a weakneſs and atrophy in the parts which I mentioned this nerve to be ſent to, after a wound in the internal lower part of the arm.

7. *RADIALIS* accompanies the humeral artery to the bending of the elbow, ferving the flexors of the cubit in its way; then paffing through the *pronator radii teres* mufcle, it gives nerves to the mufcles on the fore-part of the fore-arm, and continues its courfe near to the *radius*, beftowing branches on the circumjacent mufcles. Near the wrift, it fometimes gives off a nerve which is diftributed to the back of the hand, and the convex part of the thumb and feveral of the fingers, inftead of the branch of the mufcular. The larger part of this nerve, paffing behind the annular ligament of the wrift, gives nerves to the fhort mufcles of the thumb; and afterwards fends a branch along each fide of the fheath of the tendons of the flexors of the thumb, fore-finger, mid-finger, and one branch to the fide of the ring-finger, next to the middle one, to be loft on the concave fide of thofe fingers.

Though the *radial* nerve paffes through the *pronator* mufcle, and the *mufcular* nerve feems to be ftill more unfavourably placed within the *fupinator brevis;* yet the action of thefe mufcles does not feem to have any effect in hindering the influence of thefe nerves; for the fingers or hand can be bended while pronation is performing vigoroufly, and they can be extended while fupination is exercifed.

The manner of the going off of thefe nerves of the fingers, both from the *ulnar* and *radial*, is, that a fingle branch is fent from the trunk to the fide of the thumb and little finger fartheft from the other fingers; and all the reft are fupplied by a trunk of a nerve, which fplits into two fome way before it comes as far as the end of the *metacarpus*, to run along the fides of different fingers that are neareft to each other.

It might have been obferved, that, in defcribing the pofterior branches of the *ulnar* and *mufcular nerve*, I did not mention the particular fingers, to the convex part of which they are diftributed. My reafon for this omiffion is, the uncertainty of their diftribution; for

for though ſometimes theſe poſterior branches go to the ſame fingers, to the concave part of which the anterior branches of the *ulnar* and *radial* are ſent, yet frequently they are diſtributed otherwiſe.

The ſituation of theſe brachial nerves in the *axilla*, may let us ſee, how a weakneſs and atrophy may be brought on the arms by long continued preſſure of crutches, or ſuch other hard ſubſtances on this part; and the courſe of them, from the neck to the arm, may teach us, how much better effects veſicatories, or ſtimulating nervous medicines, would have, when applied to the ſkin, covering the tranſverſe proceſſes of the *vertebræ* of the neck, or at the *axilla*, than when they are put between the ſhoulders, or upon the ſpinal proceſſes, in convulſions or palſies of the ſuperior extremities, where a *ſtimulus* is required.

The *TWELVE DORSAL* nerves of each ſide, as ſoon as they eſcape from between the *vertebræ*, ſend a branch forward to join the intercoſtal, by which a communication is made among them all; and they ſoon likewiſe give branches backwards to the muſcles that raiſe the trunk of the body, their principal trunk being extended outwards to come at the furrow in the lower edge of each rib, in which they run toward the anterior part of the *thorax*, between the internal and external intercoſtal muſcles, giving off branches in their courſe to the muſcles and teguments of the *thorax*.

The *FIRST* dorſal, as was already obſerved, is particular in this, that it contributes to form the brachial nerves; and that the two branches of the intercoſtal, which come down to the *thorax*, form a conſiderable ganglion with it.

The *SIX* lower dorſal nerves give branches to the diaphragm and abdominal muſcles.

The *TWELFTH* joins with the firſt lumbar, and beſtows nerves on the *muſculus quadratus lumborum* and *iliacus internus*.

May not the communications of all theſe nerves be one reaſon, why the parts they ſerve act ſo uniform-

 ly

ly and conjunctly in reſpiration, and conſpire together in the convulſive motions of coughing, ſneezing, &c.—The twitching ſpaſms that happen ſometimes in different parts of the muſcles of the *abdomen*, by an irritation on the branches of the lower dorſal nerves, are in danger of occaſioning a miſtake in practice, by their reſemblance to the colic, *nephritis*, &c.—The communications of theſe lower ones with the intercoſtals may ſerve to explain the violent effort of the abdominal muſcles in a *teneſmus* and in child-bearing.

As the intercoſtal is larger in the *thorax* than any where elſe, and ſeems to diminiſh gradually as it aſcends and deſcends, there is cauſe to ſuſpect, that this is the trunk from which the ſuperior and inferior pairs are ſent as branches.

The *FIVE LUMBAR* nerves on each ſide communicate with the intercoſtal and with each other, and give branches backwards to the loins.

The *FIRST* communicates with the laſt dorſal, ſends branches to the abdominal muſcles, to the *pſoas* and *iliacus*, and to the teguments and muſcles on the fore-part of the thigh; while its principal branch joins with the other nerves, to form the crural nerve.

The *SECOND LUMBAR* nerve paſſes through the *pſoas muſcle*, and is diſtributed nearly in the ſame way as the former; as is alſo the *THIRD*.

Branches of the *ſecond*, *third*, and *fourth*, make up one trunk, which runs along the fore-part of the *pelvis;* and paſſing in the notch at the fore-part of the great hole common to the *os pubis* and *iſchium*, is ſpent on the *adductor* muſcles, and on the teguments on the inſide of the thigh. This nerve is called the *OBTURATOR* or *POSTERIOR CRURAL NERVE*.

By united branches from the *firſt*, *ſecond*, *third*, and *fourth* lumbar nerves, a nerve is formed that runs along the *pſoas* muſcle, to eſcape with the external iliac veſſels out of the *abdomen*, below the tendinous arcade of the external oblique muſcle. This nerve, which

which is named the *ANTERIOR CRURAL*, is diſtributed principally to the muſcles and teguments on the fore-part of the thigh. A branch, however, of this nerve runs down the inſide of the leg to the upper part of the foot, keeping near to the *vena ſaphæna;* in opening of which with a lancet at the ancle, the nerve is ſometimes hurt, and occaſions ſharp pain at the time of the operation, and numbneſs afterwards.

The remainder of the fourth lumbar and the fifth join in compoſing the largeſt nerve of the body; which is ſoon to be deſcribed.

Whoever attends to the courſe of theſe lumbar nerves, and of the ſpermatic veſſels and nerves upon the *pſoas* muſcle, with the oblique paſſage of the *ureter* over that muſcle, will not be ſurpriſed, that when a ſtone is paſſing in this canal, or even when it is inflamed, the trunk of the body cannot be raiſed erect, without great pain; or that the ſkin of the thigh becomes leſs ſenſible, and the thigh is drawn forward, and that the teſticle often ſwells and is drawn convulſively towards the ring of the abdominal muſcles.

The *SIXTH PAIR* of the falſe *VERTEBRÆ* conſiſt each of ſmall poſterior branches ſent to the hips, and of large anterior branches.

The *firſt*, *ſecond*, and *third*, after coming through the three upper holes in the fore-part of the *os ſacrum*, join together with the fourth and fifth of the loins, to form the largeſt nerve of the body, which is well known by the name of the *SCIATIC* or *ISCHIATIC* nerve: This, after ſending large nerves to the different parts of the *pelvis*, and to the external parts of generation, and the *podex*, as alſo to the muſcles of the hips, paſſes behind the great *tuber* of the *os iſchium*, and then over the *quadrigemini* muſcles, to run down near to the bone of the thigh at its back-part, giving off nerves to the neighbouring muſcles and teguments. Some way above the ham, where it has the name of the *poplitæus* nerve, it ſends off a large branch that paſſes over the *fibula*, and ſinking

in

in among the muſcles on the anterior external part of the leg, runs down to the foot, to be loſt in the upper part of the larger toes, ſupplying the neighbouring muſcles and teguments every where in its paſſage. The larger branch of the *ſciatic*, after giving branches to the muſcles and teguments about the ham and knee, and ſending a large cutaneous nerve down the calf of the leg, to be loſt at laſt on the outſide of the foot, and upper part of the leſſer toes, ſinks below the *gemellus* muſcle, and diſtributes nerves to the muſcles on the back of the leg; among which it continues its courſe, till, paſſing behind the internal *malleolus*, and in the internal hollow of the *os calcis*, it divides into the two plantar nerves: The internal of which is diſtributed to the toes in the ſame manner that the *radial* nerve of the hand ſerves the concave ſide of the thumb and fingers; and the external *plantar* is divided and diſtributed to the ſole of the foot and toes, nearly as the *ulnar* nerve is in the palm of the hand, and in the concave part of the fingers.

Several branches of theſe nerves, that ſerve the *inferior extremities*, pierce through muſcles.

By applying what was ſaid of the nerves in general to the particular diſtribution of the nerves of the *inferior extremities*, we may ſee how people with fractured legs, eſpecially where there are ſplinters, ſhould be ſubject to convulſive ſtartings of the fractured member.—Why, upon tying the blood veſſels in an amputation of the leg, the patients ſhould ſometimes complain of violent pain in their toes;—why ſuch patients ſhould alſo be troubled with ſtartings;—why, for a conſiderable time after the amputation of the diſeaſed limb, when the ſuppuration is well advanced, they ſhould complain of pain in the ſore which occaſioned the amputation.

The *FOURTH*, which, with the two following, is much ſmaller than the three ſuperior, ſoon is loſt in the *veſica urinaria* and *inteſtinum rectum*.

The

The *FIFTH* comes forward between the extremity of the *os ſacrum* and *coccygis*, to be diſtributed principally to the *levatores ani.*

The *SIXTH*, which ſome think to be only a production of the *dura mater*, advances forward below the broad ſhoulders of the firſt bone of the *os coccygis*, and is loſt in the *ſphincter ani*, and teguments covering it.

The branches of the four laſt cervical nerves, and of the firſt dorſal, which are beſtowed on the *ſuperior extremities*, and the two crurals, with the ſciatic, which are diſtributed to the *inferior extremities*, are much larger proportionally to the parts they ſerve, than the nerves of the trunk of the body, and eſpecially of the *viſcera*, are; and for a very good reaſon, that, in the moſt common neceſſary actions of life, a ſufficient quantity of fluid, on which the influence of nerves ſeems to depend, may be ſupplied to the muſcles there, which are obliged to perform more frequent and violent contractions than any other parts do.—The ſize of the nerves of the *inferior extremities* ſeems larger proportionally than in the *ſuperior extremities*; the *inferior extremities* having the weight of the whole body to ſuſtain, and that frequently at a great diſadvantage.—What the effect is of the nerves here being injured, we ſee daily, when people happen, by ſitting wrong, to compreſs the ſciatic nerve, they are incapable for ſome time after to ſupport themſelves on the affected *extremity*: And this is ſtill more remarkable in the *ſciatic* or *hip-gout*, in which the member is not only weakened, but gradually ſhrivels and waſtes.

THE

THE

DESCRIPTION

Of the HUMAN

LACTEAL SAC AND DUCT.

THE *receptaculum chyli* of *Pecquet*, or *ſaccus lacteus* of *Van Horne*, is a membranous ſomewhat pyriform bag, two-thirds of an inch long, one-third of an inch over in its largeſt part when collapſed; ſituated on the firſt *vertebra* of the loins to the right of the *aorta*, a little higher than the right emulgent artery, behind the right inferior muſcle of the diaphragm: It is formed by the union of three tubes, one from under the *aorta*, the ſecond from the interſtice of the *aorta* and *cava*, the third from under the emulgents of the right ſide. The *lacteal ſac*, becoming gradually ſmaller towards its upper part, is contracted into a ſlender membranous pipe, of about a line diameter, which is generally named the *THORACIC DUCT*. This paſſes betwixt the muſcular *appendices* or inferior muſcles of the diaphragm, on the right of, and ſomewhat behind the *aorta*; then, being lodged in the cellular ſubſtance behind the *pleura*, it mounts between the *aorta* and the *vena azygos*, as far as the fifth *vertebra* of the *thorax*, where it is hid by the *azygos*, as this vein riſes forwards to join the deſcending or ſuperior *cava*; after which the duct paſſes obliquely over to the left ſide behind the *œſo-*

œſophagus, *aorta deſcendens*, and the great curvature of the *aorta*, until it reaches the left carotid artery; behind which, on the left ſide of the *œſophagus*, it runs to the interſtice of the firſt and ſecond *vertebra* of the *thorax*, where it begins to ſeparate from the carotid, ſtretching farther towards the left internal jugular vein by a circular turn, whoſe convex part is uppermoſt. At the top of this arch it ſplits into two for a line and an half; the ſuperior branch receiving into it a large lymphatic veſſel from the cervical glands. This lymphatic veſſel appears, by blowing air and injecting liquors into it, to have few valves. When the two branches are again united, the duct continues its courſe towards the internal jugular vein, behind which it deſcends, and, immediately at the left ſide of the inſertion of this vein, enters the ſuperior poſterior part of the left ſubclavian vein, whoſe internal membrane duplicated, forms a ſemilunar valve that is convex externally, and covers two-thirds of the orifice of the duct; immediately below this orifice, a cervical vein from the *muſculi ſcaleni*, enters the ſubclavian.

The coats of the *ſac* and *duct* are thin tranſparent membranes; from the inſide of which, in the duct, ſmall ſemilunar valves are produced, moſt commonly in pairs; which are ſo ſituated as to allow the paſſage of liquors upwards, but oppoſe their return in an oppoſite courſe. The number of theſe is generally ten or twelve.

This is the moſt ſimple and common courſe, ſituation, and ſtructure of the *receptaculum chyli* and *thoracic duct*; but having had occaſion to obſerve a variety in theſe parts, of different ſubjects, I ſhall ſet down the moſt remarkable of them.

The ſac is ſometimes ſituated lower down than in the former deſcription; is not always of the ſame dimenſions; is not compoſed of the ſame number of ducts; and frequently appears to conſiſt of ſeveral ſmall cells or ducts, inſtead of being one ſimple cavity.

The

The diameter of the duct is various in moſt bodies, and is ſeldom uniform in the ſame ſubject; but frequently ſudden enlargements or *ſacculi* of it are obſervable.—The diviſions which authors mention of this duct are very uncertain. I have ſeen it divided into two, whereof one branch climbed over the forepart of the *aorta* at the eighth *vertebra* of the *thorax*, and at the fifth ſlipped behind that artery, to join the other branch which continued in the ordinary courſe.—The precise *vertebra*, where it begins to turn to the left ſide, is alſo uncertain.—Frequently it does not ſplit at its ſuperior arch; in which caſe a large ſac is found near its aperture into the ſubclavian vein.—Generally it has but one orifice; though I have ſeen two in one body, and three in another: Nay, ſometimes it divides into two, under the curvature of the great artery; one goes to the right, another to the left ſubclavian vein; and I have found this duct diſcharging itſelf entirely into the right ſubclavian.—The lymphatic veſſel which enters its ſuperior arch, is often ſent from the *thyroid* gland.

Whether is not the ſituation of the *receptaculum chyli* ſo much nearer the muſcular *appendices* of the diaphragm in men than in brutes, deſigned to ſupply the diſadvantageous courſe the chyle muſt otherwiſe have in our erect poſture?

Does not the deſcent of the end of the duct to the ſubclavian vein, and the opening of the lymphatic into the top of the arch, contribute to the ready admiſſion of the chyle into that vein?

FINIS.

AN

ESSAY

ON

Comparative Anatomy.

—Vos minime fugit, plures esse humani corporis partes, quarum structura, et officium, etsi non aliunde quam ex bestiis desumpta sint, nunc tamen in scholis accipiuntur, atque probantur.

Ant. M Valsalva in dissert. Anatom. tertia.

Incidenda autem animalia, quibus partes illæ quarum actiones quærimus, eadem atque homini sunt, aut certe similes iis; ex quibus sine metu erroris judicare de illis hominis liceat Quin et reliqua, si modo aliquam habeant ad hominem similitudinem, quantulacunque sit, idonea sunt ad aliquid suppeditandum.

Albini Præf. ad Harvei Exercitationem de motu cordis.

THE THIRD EDITION.

EDINBURGH:

PRINTED FOR W. GORDON PARLIAMENT-SQUARE, AND J. DICKSON FRONT OF THE EXCHANGE.

M,DCC,LXXXII.

ADVERTISEMENT

TO THE

READER.

THE following ſheets were found among the papers of a phyſician lately deceaſed, and ſent by a friend of his to the bookſeller, with liberty to print them. As the ſubject appeared uſeful, they were preſented to two eminent phyſicians in town for their approbation: One of them was ſo good as to write the following letter, which, with difficulty we obtained leave to print, as it will ſerve for a preface to the whole. From what he there ſays, in relation to the ſubject and treatiſe, we preſume the publiſhing it muſt be a ſervice done the public.

A LETTER, &c.

SIR,

I HAVE read over the papers on *Comparative Anatomy*, which I now return you with thanks by this bearer. You desire my thoughts on the subject and treatise, and indeed the pleasure I had in the perusal makes your demand but just.—What is called *Comparative Anatomy* was certainly the first branch of the science that was cultivated, and from it the earliest anatomists formed their notion and system of the human body. The natural prejudices of mankind, and in some sense common humanity, opposed any attempts to be made in the other way. As the first physicians were philosophers, and this part of natural knowledge more immediately related to medicine, they particularly applied to it. Democritus, who, according to some, was the master of Hippocrates, spent much time in dissecting brutes, and examining their several parts. He applied himself with such eagerness to this study, as to incur the censure of madness. His design was to examine *the nature of the bile, and learn the seat and causes of diseases.* That this science was much improved by the times of Hippocrates, is very apparent from his writings, which are intermixed with reasonings drawn from it, and some parts of his physiology are only applicable to brutes. These passages appear to us exceeding obscure, often false and contradictory, and have for that reason been rejected by some very great critics.—But is not this owing to our own ignorance? We do not well understand the then received system of anatomy, and his terms and names do not correspond to ours. The small tract *de Vulneribus Capitis* is, I think,

think, as great a mafter-piece in its kind as the *Coacæ Prædictiones*. Yet the firft has been efteemed by fome lame and imperfect; and afforded occafion for many difputes and wranglings, and all this becaufe not underftood: Anatomifts however have done by Hippocrates in moft cafes as the critics with Homer, made him the mafter of all human and divine fcience. Not a new divifion of a bone, or difpute about a procefs of articulation, but has been referred to his judgment, and he has often been made to explain what he never dreamed of. Galen, the father of anatomifts, is for the fame reafon in many places become an obfcure writer. He is accufed and defended by the greateft fucceeding mafters. Vefalius, the great reftorer of anatomy, will not allow accuracy or truth in many of his defcriptions; they are according to him taken from brutes, and obtruded on the world for *human*.

The other anatomifts treat Vefalius much in the fame manner, and with uncommon fagacity and unwearied application have found out variations and *lufus naturæ* in particular parts, that they may eftablifh Galen's defcriptions, and condemn thofe of Vefalius. This is particularly the cafe with Euftachius in his treatife on the kidneys. How fhall we now underftand Galen, and judge between thefe great anatomifts. It is *Comparative Anatomy* alone can extricate us from this confufion, as it will teach us, when Galen and others defcribed and reafoned from brutes, and when not. We fhall then find (I believe) that the greateft part of his defcriptions was taken from brutes, which he transferred by analogy to the human body, and fo are inaccurate; that a few were taken from the human fubject, and are not capable of being otherwife applied. This ftudy he himfelf recommends with great earneftnefs to his fcholars, and it is obfervable that the moft eminent anatomifts firft difcovered their genius, by an early attachment to

 it.

it. This was particularly the caſe of Veſalius and Valſalva *.

As the firſt knowledge the ancients gained in anatomy was from the diſſection of brutes, ſo they formed the names and terms of art from the moſt natural appearance the part afforded, and that in different animals. Thoſe names were applied to the correſponding parts in the human body, and retained by ſucceeding anatomiſts to avoid a multiplicity of words. This however produces one bad effect, that it muſt miſlead us in our conceptions, as thoſe names are often very improper epithets in the human ſubject. The author has elegantly remarked ſeveral of theſe. The name of right and left *ventricle* is apt to give a wrong idea of the poſition of the heart, and the *aorta aſcendens* and *deſcendens* has impoſed on ſome of the maſters in anatomy, who, it is plain, have taken their figures from the *name*. Diſputes have ariſen about the *appendix vermiformis*, &c. which are all cleared up when we once view the part in the animal whence the name was taken. A ſhort technical dictionary, with an account of the ſubjects whence the names of the ſeveral parts were derived would be of great uſe to ſtudents, and is one of the *deſiderata* in anatomy †.

The intention of nature in the formation of the different parts, can no where be ſo well learned as from this ſcience; that is, if we would underſtand phyſiology and reaſon on the functions in the animal œconomy, we muſt ſee how the ſame end is brought about in other ſpecies.—We muſt contemplate the part or organ in different animals, its ſhape, poſi-

* Gaudebat enim avicularum, aliorumque animalculorum diſſectionibus, eorumque exta curioſius, quam pro illa ætate, rimabatur: quam ego præſignificationem, non in Veſalio tantum, ſed in aliis quoque pueris fuiſſe ſcio, qui, cum adoleviſſent, anatomiæ penitus ſe dediderunt. *Morgagni Comment. de vita Valſalvæ.*

† Such a treatiſe might in a great meaſure be collected from Sylvius's works, and Fœtius's OEconomia Hippocratis. Camerarius did ſuch a work under the title of Διασκευὴ ὀνομαστικὴ, but it is a rare book.

tion,

tion, connection with the other parts, *&c.* and obſerve what thence ariſes.—If we find *one common effect* conſtantly produced, though in a very different way, then we may ſafely conclude that this is the *uſe* or *function* of the part; this reaſoning can never betray us, if we are but ſure of the facts. The writers in phyſiology have generally taken another rout, and one favourite theſis or other ſerves to explain the whole or moſt of the ſyſtem. An *innate* and *concocting heat*, *acids*, *menſtruums*, &c. have all had their ſucceſſive reigns and patrons. And, in in truth, phyſicians ſeem not to have ſufficiently conſidered the importance of this ſtudy to form a complete phyſiology, which muſt ever be the great baſis of their art. They have beſtowed pains in examining the human body, diſſected minutely its ſeveral parts, traced out (perhaps often invented) a new diviſion of a muſcle;—but how little has phyſic been promoted by all this? The moſt accurate deſcription of the human ſtomach, with all its veins, arteries, nerves, *&c.* will never rightly explain digeſtion.—What muſt we then do?—examine it in the other ſpecies of animals, mark there its differences and the effects, compare theſe with the human, and then ſhall we in ſome meaſure be able to judge what are the principal inſtruments, and how they are employed in this compound action. Any other way of reaſoning (as the author well obſerves), will never bring us to the ſolution of a philoſophical or medical problem. It muſt indeed be confeſſed, that this method is tedious and ſlow; many obſervations muſt firſt be made, and the labour of ſearching and examining gone through, before we can have proper materials to build on. Yet theſe are the hard conditions on which the knowledge of natural cauſes is to be obtained, which, as a great genius ſays, "Tam facile ſolertia vinci poſ- "ſunt, quam ſolent conatibus vulgaribus difficulter "cedere."

Of this kind of reaſoning, we have many beautiful inſtances in the following papers; ſuch is the account

of

of the poſition of the *duodenum*, the hiſtory of the *thymus* and *thyroeid gland*, their uſe and mutual proportion, the uſe of the *ſpleen*, &c. This laſt he explains in ſo ſhort and maſterly a manner, as you'll find more argument in the few lines upon it, that is to be collected from whole treatiſes on the ſubject. But as his deſign was to give a deſcription of the ſeveral ſpecies, or rather their principal differences, he chiefly confines himſelf to this: So in the anatomy of the dog he compares the different poſition, ſhape, length, *&c.* of the ſeveral parts with the correſponding parts in man, and from that one circumſtance, the *difference* of an erect and horizontal poſture, explains all the variations. This reaſoning then gives ſolution to many difficulties in the human anatomy; why the *ſpleen* ſo firmly attached to the *diaphragm*, why the *omentum* reaches only ſo far, why the poſterior part of the *bladder* only covered by the *peritonæum*, &c. —— There have been diſputes about the *fiſſure* in the human *liver*, and different accounts given. Theſe all vaniſh, when we conſider this *viſcus* in different animals. We then find that there are more or fewer diviſions, according to the greater or leſſer flexility of the *ſpine*. The ſame rule holds with regard to the diviſions of the *lungs*. This reaſoning likewiſe excludes the pretended uſe of the *ligament* in the human *liver*. And in ſhort we can underſtand but little of our own ſtructure, unleſs we ſtudy that of other animals; we ſhall then find that the ſeveral variations are *relative* and depend on the different way of life; that is, one leading *ſpeciality* draws after it a great many more, in which nature is always an oeconomiſt and takes the ſhorteſt rout.

The beautiful *gradation* of nature in the different orders of beings, is very remarkable, and ſtrikes the mind firſt, as being moſt obvious; but when we take any one ſpecies, the caſe there is ſtill the ſame, and we obſerve as ſurpriſing a difference. Thus in the animal kingdom, ſome are provided with *lungs*, when others are deprived of theſe breathing organs; ſome have

have a muſcular *diaphragm* and ſtrong *abdominal muſcles*, others a mere *membrane*; ſome have *lecteals*, others want them. It muſt be very entertaining to learn how theſe differences and deficiencies are adjuſted and ſupplied; 'tis then from this ſcience alone we can underſtand that *ſimplicity* of nature, which is much talked of, and but little underſtood. Hence likewiſe we muſt learn what to think of animals *perfect* and *imperfect*.——

Anatomiſts have made a noiſe about the different ſtructures of the ſame part in the human body, and been at great pains to make collections of thoſe *luſus naturæ* as they call them; which, becauſe they are rare, are for that very reaſon of no great conſequence to be known. The epithet however is extremely proper; for the moſt remarkable of them are tranſitions from the *order* or *law* of nature that obtains in one ſpecies, to that of another. Thus it has been obſerved (though very rarely) that the *liver* was ſituated in the left *hypochondrium*; but as our author remarks, it is not peculiar to it to lye on the right ſide in animals; for in fowls it lies equally on both, and in fiſhes moſtly on the left.

It is ſurpriſing that we have no tolerable treatiſe on this ſubject, which is in itſelf ſo entertaining and ſo conducive to promote medicine. Thoſe, who have made attempts this way, have only collected and ranged in order ſome particular *ſpecies*, ſuch as birds or fiſhes. They have likewiſe with great labour given us figures and deſcriptions of them,—but all this is little elſe than mere amuſement. 'Tis the ſtructure of the internal organs we ſeek after, and the manner how the different functions of the animal oeconomy are performed. Their hiſtories of theſe are every way defective and erroneous. There are indeed noble hints to be found in the writings of ſome of our modern anatomiſts, particularly thoſe of the immortal Dr *Harvey*. That great man well underſtood the importance of this ſcience to advance medicine, and accordingly employed the moſt of his time

time in diffecting animals of different tribes, and making experiments on them: by which means he made the greateft difcovery that ever was in the fcience, and laid the foundation of the prefent fyftem. He had certainly left us other treatifes on the fubject, had he not been interrupted by the civil wars. The phyficians who lived then, imitating his example, made many new experiments on the bodies of brutes, changing their juices by transfufing of new liquors, accurately marking the effects, &c. that all this might be transferred to the human body; and indeed, from the application of thefe reafonings, to the obfervations they made on morbid bodies, the fcience feemed faft advancing to that phyfical certainty, which can be attained from experiment and obfervation. But alas! this fpirit died with thefe great men, and theory and calculation came in its place. *Mathematics*, it was faid, could alone bring the fcience to certainty, and throw out conjecture. The quantity and velocity of the blood, the force of the heart, diameters of the veffels, &c. were fubjected to meafure and number, and difeafes next were to be accounted for all in a mathematical manner.—This method however did not fucceed according to wifh; for firft thefe great geniufes difagreed widely in their calculations, and differed from one another; whence in place of certain conclufions we had only wranglings and difputes: not to mention, that fome of them made fuch eftimates, as muft plainly apppear ridiculous at firft fight (*). This, you'll fay, proves

(*) The ingenious Dr *Pitcairn* was the chief man in thefe parts, who gave into this way. He fuppofes the force of mufcles to be in a *compound ratio* of their length, breadth and depth; that is, as they are *homogeneous folids* in the *ratio* of their weights. Whence knowing the force of any one mufcle, we can by the rule of proportion (from their weights) determine *that* of another. This he applies to the ftomach, and by the computation its mufcular force is equal at leaft to 117088 lb. weight.——That mufcles are in that proportion, is a mere *hypothefis*, for which the doctor does not offer the fmalleft proof; and had he affigned five ounces as the weight of the ftomach, he had been nearer the truth. This is one glaring inftance, how much *theory* and *whim* may prevail with the greateft of men over common *fenfe*.

nothing

nothing, it was the fault of the artiſts, who aſſumed wrong hypotheſes for their calculations, or were not perhaps accurate in their obſervations. True,—but whoſe fault was it to adapt figure and number to a ſubject which refuſes them, through its numberleſs deviations from fixed laws and conditions?—Is an animate body a mere bundle of hard conical elaſtic tubes, and the heart a pump forcing the liquors through? Are then all the veſſels exact cones, or have any two *anatomiſts* agreed in their meaſures of them? Do they not yield every way? And are they not continually obſtructed in different places? Are they not many different attractions prevailing for the ſeveral ſecretions, and many different forces acting on the veſſels at the ſame time which can never be determined? &c. Theſe and ſuch like conſiderations will ſoon convince us how little the practice of medicine is to be promoted by thoſe ſpeculations (*). If theſe gentlemen meant by mathematical reaſoning phyſical experiments, then no one ever doubted of this, no more than they do of the uſe of mathematics in natural philoſophy itſelf. But as this ſeems not to be their ſenſe of the matter, they ſhould point out a few diſeaſes which this ſcience has explained, and wherein it has corrected the received practice—But I am quite got from the ſubject to what is foreign. To return then, *Comparative Anatomy* has hitherto been treated but by pieces. Thus ſome writing on the human eye, have examined the eyes of other animals; and ſo with regard to the heart, &c. Some have given us the deſcription of

(*) The authority of *Hippocrates* is often adduced in this argument, for which they cite two paſſages. In the one he recommends the ſtudy of *aſtronomy*, as neceſſary to a phyſician, and in the other, that of *arithmetic* and *geometry*.——The firſt he did from his belief in the influence of the *ſtars*, and the ſecond from his veneration for the *Pythagoric numbers*; in the myſteries of which he founded his theory of the *criſes* in acute diſeaſes: Both theſe conſiderations then are foreign to the purpoſe, nor is there in any of his genuine writings the ſmalleſt veſtige of this kind of reaſoning. On the contrary *Celſus* ſays of him, *Primus ab ſtudio ſapientiæ medicinam ſeparavit.*

one

one particular animal, others of another. But no one author, as I know of, has given us a ſyſtem of this ſcience where we might have a ſummary view of the moſt material differences in the ſtructure of animals. There are indeed compends of this ſcience if you will, which are eſteemed by many, and were wrote with the noble deſign of illuſtrating the wiſdom and goodneſs of our maker. But thoſe who compoſed them were not anatomiſts themſelves, ſo could only collect from others, which they often do without any judgment—for how voluminous ſoever their works may be, yet if you'll ſtrip them of their repeated exclamations, citations of authors and books, the many ſtrange and ſurpriſing ſtories, all told however by creditable vouchers, you'll have little left behind beſides an indigeſted chaos of hiſtories and deſcriptions, ſome true and many falſe. The argument however was popular, and they could not fail of pleaſing.

The author of theſe few ſheets is certainly a great maſter of the ſubject, and has here laid down an uſeful plan, which will not be difficult for others to compleat. The deſcriptions, 'tis eaſy to ſee, are all taken from the life, and his reaſoning plain and concluſive. Theſe are intermixed with many practical obſervations in medicine and ſurgery, which muſt equally inſtruct and entertain the reader.—You have now a few looſe reflections on this ſubject, wherein I have entirely confined myſelf to that light, in which it is here treated. I ſhall only remark one thing more, that the author's modeſty is at leaſt equal to his capacity and knowledge ; a rare quality to be met with in an anatomiſt ! Read him on the ſubject of the *Human Alantois*, and obſerve his concluſion of the argument. You muſt then ſay, it had been happy for the public, if half ſo much candour and ſelf diffidence had prevailed in the diſputes among the learned The world had been more inſtructed, and they more juſtly eſteemed.

I am, Sir,

Your moſt humble Servant.

AN

ESSAY

ON

Comparative Anatomy.

The INTRODUCTION.

THE principal advantages of Comparative Anatomy are the following: Firſt, it furniſhes us with a ſufficient knowledge of the different parts of animals, to prevent our being impoſed upon by ſuch authors who have delineated and deſcribed ſeveral parts from brutes as belonging to the human body. Secondly, It helps us to underſtand ſeveral paſſages in the ancient writers in medicine, who have taken many of their deſcriptions from brutes, and reaſoned from them; their reaſonings have often been miſapplied (and conſequently wrong explained) by the moderns, through a fooliſh fondneſs to ſupport their own inventions, or give an air of antiquity to a favourite hypotheſis. The third and great uſe we reap from this ſcience is the light it caſts on ſeve-

ral functions in the human œconomy, about which there have been so many disputes among anatomists: These will be in a great measure cleared up by exhibiting the structure of the same parts in different animals, and comparing the several organs employed in performing the same action, which in the human body is brought about by one more complex.

In this view it is altogether needless to insist on those parts whose use is easily understood when once their structure is unravelled; thus, for instance, if we be acquainted with the action of the muscles in general, it will not be difficult to determine the use of any particular muscle, whose origin and insertion is known, if we at the same time consider the various connections of the bones to which it is fixed, and the different degree of mobility they have with respect to each other: In the same manner, if we know the use of the nerves in general, we can easily assign the use of those nerves which are distributed to any particular part. There is then no occasion for a complete *osteology*, *myology*, &c. of the several animals we shall treat of, nor need we trouble ourselves about the structure of any of the parts, unless when it serves to illustrate some of the fore-mentioned purposes.

That the first use we proposed from examining the structure of the parts in brutes is real and of consequence, is evident from looking into the works of some of the earliest and greatest masters of anatomy, who for want of human subjects, have often borrowed their descriptions from other animals. The great Vesalius, although he justly reproves Galen for this fault, is guilty of the same himself, as is plain from his delineations of the kidneys, *uterus*, the muscles of the eye, and some other parts. Nor is antiquity only to be charged with this, since in Willis's Anatomia Cerebri (the plates of which were revised by that accurate anatomist Dr Lower), there are several of the pictures taken from different brutes, especially the dog, besides those he owns to be such.

We

We ſhall give ſeveral examples of the ſecond uſe in the ſequel of the work.

The animal kingdom, as well as the vegetable, contains the moſt ſurpriſing variety, and the deſcent in each is ſo gradual, that the little tranſitions and deviations are almoſt imperceptible. The bat and flying-ſquirrel, though *quadrupeds*, have wings to buoy themſelves up in the air. Some birds inhabit the waters, and there are fiſhes that have wings, and are not ſtrangers to the airy regions; the amphibious animals blend the *terreſtrial* and *aquatic* together.

The animal and vegetable kingdoms are likewiſe ſo nearly connected, that if you take the higheſt of the one, and the loweſt of the other, there will ſcarce be preſerved any difference: For inſtance, what difference is there betwixt an oyſter, one of the of the moſt inorganiſed of the animal tribe, and the ſenſitive plant, the moſt exalted of the vegetable kingdom? they both remain fixed to one ſpot, where they receive their nouriſhment, having no proper motion of their own, ſave the ſhrinking from the approach of external injuries. Thus we obſerve a ſurpriſing chain in nature.

As there is then ſuch a vaſt variety, it is not only needleſs but impoſſible to conſider all of them particularly. We ſhall take only ſome of the moſt remarkable *genera*, and hope from what will be ſaid of them any of the intermediate degrees may be underſtood.

In treating of *quadrupeds*, we ſhall divide them into the *carnivorous*, *i. e.* thoſe that feed indifferently on animal and vegetable ſubſtances, and *granivorous*: As an inſtance of theſe laſt we ſhall take the ruminant kind. The fowls we ſhall alſo divide into thoſe that feed on grain and thoſe that feed on fleſh. The diſtinction we ſhall make in treating of fiſhes, ſhall be of thoſe that have lungs, and thoſe that have them not. The firſt indeed are with difficulty procured, and at the ſame time differ very little from *quadrupeds*.

As the ſtructure of inſects is ſo very minute, and lends us but little aſſiſtance for the ends propoſed, we purpoſely omit them.

In inquiring into the ſtructure of different animals, we ought to be previouſly acquainted with the form of their body, manner of life, kind of food; or, in ſhort, with their natural hiſtory, which will lead us to account for the reaſon of their different ſtructure, and thence explain the actions of the human body.

Of

Of Quadrupeds *in General.*

ALL *quadrupeds* have a covering of hair, wool, *&c.* to defend them from the injuries of the weather, which varies in thicknefs according to the feafon of the year, and difference of the climate: Thus in Ruffia and the northern countries, the furs are very thick and warm, while the little Spanifh lap-dogs, and Barbary cows, have little or no hair at all.

The *cutis* and *cuticula* in *quadrupeds* are difpofed much in the fame way as the human, only more elaftic; immediately under this there is a very thin cutaneous mufcular fubftance called *panniculus carnofus*, which is common to all *quadrupeds*, the *porcine* kind excepted; this principally covers the trunk, ferving to fhrivel the fkin, in order to drive off infects, their tails and heads not being fufficient for this purpofe, while their extremities are employed in their fupport and progreffion.

It has probably been from obferving fome mufcles of the human body, fuch as the *platyfma myoides*, *cremafter*, and *frontales*, and the collapfed *tunica cellulofa* of emaciated fubjects, to refemble this thin mufcle, that fome of the older anatomifts reckoned fuch a *panniculus* among the common *teguments* of the human body. This *Carolus Stephanus* has well obferved.

Moft part of *quadrupeds* want *clavicles*, whereby their anterior extremities fall upon their cheft, fo as to make their *thorax* proportionally narrower than the human. This fmall diftance of their anterior extremities is very neceffary for their uniform progreffion: Apes indeed and fquirrels have *clavicles* to allow them a more full ufe of their extremities in climb-

ing, but when they ſit down on all-four they walk but indifferently.

The Anatomy of a Dog.

WE may firſt obſerve of this animal, as indeed of moſt *quadrupeds*, that its legs are much ſhorter in proportion to its trunk than in man, the length of whoſe ſteps depends entirely on the length of his inferior extremities; however, to balance this, the trunk of the animal is proportionably longer and ſmaller, his ſpine more flexible, by which he is able at each ſtep to bring his poſterior extremities nearer to his anterior. His common *teguments* are much akin to thoſe of other *quadrupeds*, only they allow little or no paſſage for ſweat, but when he is overheated, the ſuperfluous matter finds an exit by the ſalivary glands, for he lolls out his tongue and ſlavers plentifully.

The pyramidal muſcles are wanting, to ſupply which the *rectus* is inſerted fleſhy into the *os pubis*.

The *omentum* reaches down to the *os pubis*, which conſidering the poſture of the animal we will find to be a wiſe proviſion, ſince its uſe is to ſeparate an oily liquor for lubricating the guts and facilitating their periſtaltic motion; ſo in our erect poſture the natural gravity of the oil will determine it downward, but in the horizontal poſition of theſe creatures, if all the *inteſtines* were not covered, there would be no favourable derivation of the fluid to the guts lying in the poſterior part of the *abdomen*, which is the higheſt; and beſides, had the *omentum* reached much farther down in us, we had been in continual hazard of an *epiplocele*, which the dog is not ſubject to, as his *viſcera* don't preſs ſo much on the rings of the *abdominal* muſcles. The inferior and anterior *lamella* of the *omentum* is fixt to the ſpleen, *fundus* of the ſtomach, *pylorus*, liver, &c. in the ſame way as the human, but the ſuperior having no *colon* to paſs over,

over, goes directly to the back-bone. This serves to explain the formation of the ſmall *omentum* in the human body, which is nothing but the large *omentum*, having loſt its fat, paſſing over the ſtomach and *colon*, where it reaſſumes its *pinguedo*, ſo proceeds and is firmly attached to the liver, ſpine, *&c.* The ſtriæ of fat are pretty regularly diſpoſed through it, accompanying the diſtribution of the blood-veſſels to guard them from the preſſure of the ſuper-incumbent *viſcera*.

This animal's ſtomach, though pretty much reſembling the human in its ſhape, is ſomewhat differently ſituated, It lies more longitudinal, as indeed all the other *viſcera* do, to accommodate themſelves to the ſhape of the cavity in which they are contained, that is, its inferior orifice is much farther down with reſpect to the ſuperior than the human: By this means the groſs food has an eaſier paſſage into the *duodenum*. Again, the *fundus* of the human ſtomach, when diſtended, ſtands almoſt directly forwards, which is occaſioned by the little *omentum* tying it ſo cloſe down to the back-bone, *&c.* at it's two orifices; but it not being fixed in that manner in the dog, the *fundus* remains always poſterior: This alſo anſwers very well the ſhape of the different cavities, the diſtance betwixt the *cardia* and *fundus* being greater than that betwixt the two ſides. It ſeems to be much larger in proportion to the bulk of the animal than the human, that it might contain a greater quantity of food at once, which was very neceſſary, ſince this animal cannot at any time get its ſuſtenance as men do. The *turbillion* is not ſo large, nor is there any coarction forming the *antrum williſii* as in the ſtomach of man. It is conſiderably thicker and more muſcular than ours for breaking the coheſion of their food, which they ſwallow without ſufficient chewing. Hence it is evident the force of the ſtomach is not ſo great as ſome would have it, nor its contraction ſo violent; otherwiſe that of dogs would be undoubtedly wounded by the ſharp bones, *&c.*

&c. they always take down ; for the contraction here is ſtill greater than in the human ſtomach, which is much thinner. The *rugæ* of the *tunica villoſa* are neither ſo large nor ſituated tranſverſely as in the human, but go from one orifice to the other ; the reaſon of which difference is, perhaps, that they might be in leſs danger of being hurt by the hard ſubſtances this creature frequently feeds upon, and for the ſame reaſon there is not the like coarction at their *pylorus*.

The *inteſtines* of this animal are proportionally much ſhorter than ours, for the food which theſe creatures moſtly uſe, ſoon diſſolves and then putrifies ; on which account there was no occaſion for a long tract of *inteſtines*, but on the contrary that it ſhould be quickly thrown out of the body : the ſame is to be obſerved of all the carnivorous animals. The *muſcular coat* of the *inteſtines* is alſo ſtronger than the human, to protrude the hard bones, leſt they ſhould ſtop ſomewhere in the canal.

The *valvulæ conniventes* are leſs numerous, and in a longitudinal direction.

The *duodenum* differs conſiderably in its ſituation from the human ; for in man it firſt mounts from the *pylorus* upwards, backwards, and to the right ſide, then paſſes down by the gall-bladder, and marching over the right kidney and ſuperior part of the *pſoas muſcles*, makes a curvature upwards, and paſſes over the back bone and *vena cava inferior*, to the left *hypochondrium*, where it gets through the *omentum*, *meſentery* and *meſocolon* to commence the *jejunum*, being firmly tied down all the way, the *biliary* and *pancreatic ducts* entering at its moſt depending part : whereas in the dog the *duodenum* is fixed at the *pylorus* to the concave ſurface of the liver, and hangs looſe and pendulous with the *meſentery* backwards into the cavity of the *abdomen*, then turning up again is fixed to the back-bone where it ends in the *jejunum* ; the bile and *pancreatic* juice are poured into it at the moſt depending part ; therefore the ſame intention

ſeems

ſeems to have been had in view in the formation of this part in both, *viz.* the giving the chyle, after the liquors of the liver and *pancreas* are poured into it, a diſadvantageous courſe, that ſo it might be the more intimately blended with the humours before its entry into the *jejunum*, where the *lacteals* are very numerous: And thus by reaſon of their different poſture, the ſame deſign (though by a very different order of the parts) is brought about in both.

The other ſmall guts are much the ſame with ours, only ſhorter. The great guts are alſo ſhorter and leſs capacious than in the human body; and we take it for a general rule, that all animals that live on vegetable food, have not only their ſmall guts conſiderably longer, but alſo their great guts more capacious than ſuch creatures as feed on other animals. Hence man from this form of his *inteſtines* and that of the *teeth*, ſeems to have been originally deſigned for feeding on vegetables, and ſtill the moſt of his food and all his drink is of that claſs.

The reaſon of this difference ſeems to be, that as animal food is not only much more eaſily reduced into *chyle*, but alſo more prone to putrefaction, too long a *remora* of the juices might occaſion the worſt conſequences. So it was neceſſary that their receptacles ſhould not be too capacious, but on the contrary, being ſhort and narrow, might conduce to the ſeaſonable diſcharge of their contents. Whereas vegetable food being more difficultly diſſolved and converted into an animal nature, there was a neceſſity for ſuch creatures as fed on it to be provided with a long internal canal, that this food in its paſſage might be conſiderably retarded, and have time to change its *indoles* into one more agreeable to our nature. Beſides which, there is another advantage which accrues to man in particular, from having his great guts very capacious; for as he is a rational being, and moſtly employed in the functions of ſocial life, it would have been very inconvenient as well unbecoming for him to be too frequently employed

in

in ſuch ignoble exerciſes, ſo that having this large reſervoir for his *faces alvinæ*, he can retain them for a conſiderable time without any trouble.

The *appendix vermiformis* juſtly enough deſerves the name of an *inteſtinum cecum* in this ſubject, though in the human body it does not, and it has probably been from the largeneſs of this part in other animals, that the oldeſt anatomiſts came to reckon that ſmall appendicle in man as one of the great guts: On its internal ſurface we obſerve a great number of mucous glands.

The *colon* has no longitudinal ligaments, and conſequently this gut is not purſed up into different bags or cells as the human, nor does this *inteſtine* make any circular turn round the *abdomen*, but paſſes directly acroſs it to the top of the *os ſacrum*, where it gets the name of *rectum*.

At the extremity of the *inteſtinum rectum* or verge of the *anus*, there are found two bags or paunches, which contain a moſt abominable fetid mucus, for which I know no uſe, unleſs it ſerves to lubricate the ſtrained extremity of the *rectum*, and defend it againſt the aſperity of the *faeces*, or to ſeparate ſome liquor that might otherwiſe prove hurtful to their bodies. There is nothing analogous to thoſe ſacs in the human ſubject, unleſs we reckon the mucilaginous glands that are found moſt frequent and largeſt about the lower part of the *rectum*.

The *meſentery* is conſiderably longer than in the human body, for in man had the *meſentery* been very long, the guts would have fallen down on the ſtomach, &c. by reaſon of his erect poſition. The fat is here diſpoſed in the ſame way, and for the ſame reaſon, as in the *omentum*. The *interſtices* betwixt the fat are filled with a fine membrane. Inſtead of a great number of *glandulæ vagæ* to be found in the human *meſentery*, there is only one large gland to be obſerved in the middle of the *meſentery* of a dog, which from its imagined reſemblance to the *pancreas* and the name of its diſcoverers, is called *pancreas*

pancreas Asellii. The reaſon why this in man is as it were ſubdivided into many ſmaller ones, may poſſibly be, that as the guts of a human body are proportionally much longer than thoſe of this creature, it would have been inconvenient to have gathered all the *lactea primi generis* into one place, whereas by collecting a few of theſe veſſels into a neighbouring gland, the ſame effect is procured much more eaſily.

The *pancreas* in man lies croſs the *abdomen*, tied down by the *peritoneum;* but the capacity of this creature's *abdomen* not allowing of that ſituation, it is diſpoſed more longitudinally, being tied to the *duodenum* which it accompanies for ſome way. Its *duct* enters the *duodenum* about half an inch below the others.

The ſpleen of this animal differs from ours very much, both in figure and ſituation. It is much more oblong and thin, and lies more according to the length of *abdomen*, like the *pancreas*. Though the ſpleen of this creature is not firmly tied to the *diaphragm* (which was neceſſary in our erect poſture to hinder it from falling downwards) yet by the animal's prone poſition, its poſterior parts being rather higher than the anterior, it comes to be always contiguous to this muſcle, and is as effectually ſubjected to an alternate preſſure from its action as the human ſpleen is.

The human liver has no *fiſſures* or diviſions, unleſs you pleaſe to reckon that ſmall one betwixt the two *pylæ*, where the large veſſels enter: Whereas in a dog and all other creatures that have a large flexion in their ſpine, as lions, leopards, cats, &c. the liver and lungs are divided into a great many lobes by deep ſections, reaching the large blood-veſſels, which in great motions of the back bone may eaſily ſhuffle over one another, and ſo are in much leſs danger of being torn or bruiſed, than if they were formed of one entire piece, as we really ſee it in horſes, cows, and ſuch creatures as have their back-bone

back-bone ſtiff and immoveable. There is here no *ligamentum latum* connecting the liver to the *diaphragm*, which in our ſituation was neceſſary to keep the *viſcus* in its place; whereas in this creature it naturally gravitates forwards, and by the horizontal poſition of the animal is in no danger of preſſing againſt the *vena cava*: The preventing of which is one uſe generally aſſigned to this *ligament* in man. Had the liver of the dog been thus connected to the *diaphragm*, the reſpiration muſt neceſſarily have ſuffered; for as we ſhall ſee afterwards, this muſcle is here moveable at the center, as well as at the ſides: But in man the liver is fixed to the *diaphragm*, moſtly at its tendinous part; that is, where the *pericardium* is fixed to it on the other ſide; ſo that it is in no danger of impeding the reſpiration, being ſuſpended by the *mediaſtinum* and bones of the *thorax*. In conſequence of this *viſcus* being divided into ſo many *lobes*, it follows that the *hepatic ducts* cannot poſſibly join into one common trunk till they are quite out of the ſubſtance of the liver.

We come next, after having examined the *chylopoietic viſcera*, to diſcourſe of thoſe organs that ſerve for the ſecretion and excretion of urine, and firſt of the kidneys, which in this animal are ſituated much in the ſame way as in the human ſubject, but have no fat on their inferior ſurface, where they face the *abdomen*, and are of a more globular form than the human. The reaſon of theſe differences will eaſily appear, if you compare their ſituation and poſture in this animal with thoſe of a man who walks erect. They are placed in this ſubject in the inferior part of the body, ſo are not ſubject to the preſſure of the *viſcera*, which ſeems to be the principal cauſe of the fatneſs of thoſe organs in us, and perhaps may likewiſe be the cauſe of our being more ſubject to the ſtone than other animals. Hence there is no need of any cellular ſubſtance to ward off this preſſure where there would neceſſarily be fat collected; but the ſuperior part of their kidneys is pretty well covered

vered with fat, left they ſhould ſuffer any compreſſion from the action of the ribs and ſpine.

In the *internal* ſtructure there is ſtill a more conſiderable difference, for the *papillæ* do not here ſend out ſingle the ſeveral *tubuli uriniferi*, but being all united they hang down in form of a looſe pendulous flap in the middle of the *pelvis*, and form a kind of *ſeptum medium*, ſo that a dog has a *pelvis* formed within the ſubſtance of the kidney. The only thing that is properly analogous to a *pelvis* here, is that ſac or dilatation of the *ureters* formed at the union of the *ductulæ uriniferæ*. The reaſon of theſe particularities may probably be, that the liquors of this animal, as of all thoſe of the carnivorous kind, being much more acrid than thoſe that live on vegetable food, its urine muſt incline much to an alcaleſcency, as indeed the ſmell and taſte of that liquor in dogs, cats, leopards, &c. evidently ſhew, being fetid and pungent, and therefore not convenient to be long retained in the body. For this end it was proper, that the ſecerning organs ſhould have as little impediment as poſſible by preſſure, &c. in the performing their functions; and for that deſign, the mechaniſm of their kidneys ſeems to be excellently adapted: We have moſt elegant pictures in Euſtachius of the kidneys of brutes delineated, as ſuch, with a view to ſhew Veſalius's error in painting and deſcribing them for the human.

The *glandulæ* or *capſulæ atrabilariæ* are thicker and rounder than the human, for the ſame reaſon as the kidneys.

The *ureters* are more muſcular than the human, becauſe of the favourable paſſage the urine has through them; they enter the *bladder* near its *fundus*.

The bladder of urine differs conſiderably from the human, and firſt in its form, which is pretty much pyramidal or pyriform; this ſhape of the dog's bladder is likewiſe common to all *quadrupeds*, except the ape and thoſe of an erect poſture. In men it

is by no means pyriform, but has a large ſac at its poſterior and inferior part: This form depends entirely on the urine gravitating in our erect poſture to its bottom, which it will endeavour to protrude, but as it cannot yield before, being contiguous to the *os pubis*, it will naturally ſtretch out where there is the leaſt reſiſtance, that is, at the poſterior and lateral parts; and were it not for this ſac, we could not come at the bladder to extract the ſtone either by the leſſer or lateral operation of *lithotomy*. Moſt anatomiſts have delineated this wrong ſo much, that I know of none who have juſtly painted it, excepting Mr Cowper in his *myotomia*, and Mr Rully. It has certainly been from obſerving it in brutes and young children, that they have been led into this miſtake. The ſame cauſe, *viz*. the gravity of the urine, makes the bladder of a different form in brutes; in their horizontal poſition, the *cervix*, from which the *urethra* is continued, is higher than its *fundus*, the urine muſt therefore diſtend and dilate the moſt depending part by its weight.

As to its connection, it is faſtened to the *abdominal* muſcles by a proceſs of the *peritoneum*, and that membrane is extended quite over it; whereas in us its ſuperior and poſterior parts are only covered by it: Hence in man alone the high operation of *lithotomy* can be performed without hazard of opening the cavity of the *abdomen*. Had the *peritoneum* been ſpread over the bladder in its whole extent, the weight of the *viſcera* in our erect poſture would have ſo bore upon it, that they would not have allowed any conſiderable quantity of urine to be collected there; but we muſt have been obliged to diſcharge its contents too frequently to be conſiſtent with the functions of a ſocial life. Whereas by means of the *peritoneum* the urine is now collected in ſufficient quantity, the *viſcera* not gravitating this way.

You may take it for a general rule, that thoſe creatures that feed upon animal food have their bladder more muſcular and conſiderably ſtronger, and

leſs

lefs capacious than thofe that live on vegetables, fuch as horfes, cows, fwine, *&c.* whofe bladder of urine is perfectly membranous, and very large This is wifely adapted to the nature of their food, for in thefe firft, as all their juices are more acrid, fo in a particular manner their urine becomes exalted, which as its *remora* might be of very ill confequence, muft neceffarily be quickly expelled. This is chiefly effected by its ftimulating this *vifcus* more ftrongly to contract, and fo difcharge its contents. That a *ftimulus* is one of the principal caufes of the excretion of urine, we learn from the common faline diuretic medicines that are given, which are diffolved into the *ferum* of the blood, and carried down by the kidneys to the bladder: The fame appears likewife from the application of *cantharides*, or without any of thefe, when the parts are made more fenfible, as in an excoriation of the bladder, there is a frequent defire to make water. Accordingly we find thefe animals evacuate their urine much more frequently than man, or any other creature that lives on vegetable food. And if thefe creatures, whofe fluids have already a tendency to putrefaction, are expofed to heat or hunger, the liquids muft for a confiderable time undergo the actions of the containing veffels, and frequently perform the courfe of the circulation without any new fupplies of food; by which the fluids becoming more and more acrid, the creature is apt to fall into feverifh and putrid difeafes; and in fact we find that thofe caufes are fufficient to produce that fatal and melancholy diftemper, the *rabies canina, vulpina, &c.* in thefe animals; whereas thofe that feed on vegetable food feldom or never contract thefe difeafes but by infection.

The *fpermatic* veffels are much the fame way difpofed as in us; they are contained within the cavity of the *abdomen*, as the guts are within the *peritoneum*, which is fpread over them, and from which they have a membrane like a *mefentery*, fo hang loofe and pendulous in the *abdomen*: Whereas in us they are con-

tained in the cellular part of the *peritoneum*, which is tenſely ſtretched over them. At their paſſage out of the lower belly, there appears a plain perforation or holes, and from obſerving this in *quadrupeds* has ariſen the falſe notion of *hernia* or rupture among authors. This opening is of no diſadvantage to them, but evidently would have been to us, for from the weight of our *viſcera* and our continually gravitating upon theſe holes, we muſt have perpetually laboured under *enteroceles*; this they are in no hazard of, ſince in them this paſſage is at the higheſt part of their belly, and in their horizontal poſture, the *viſcera* cannot bear upon it: And to prevent even the ſmalleſt hazard, there is a looſe pendulous ſemilunar flap of fat which ſerves two uſes, as it both hinders the *inteſtines* from getting into the paſſage, and alſo the courſe of the fluids from being ſtopped in the veſſels, which is ſecured in us by the cellular ſubſtance and tenſe *peritoneum*.

The *ſeptum medium*, or conjunction of the two *tunics*, is the ſame as in men. There is next a paſſage quite down into the cavity, where the *teſticles* lie. Had the ſame ſtructure obtained in man, by the conſtant drilling down of the liquor which is ſecerned for the lubricating of the guts, we ſhould always have laboured under an *hydrocele*; but their poſture ſecures them from any hazard of this kind; indeed your very fat lap-dogs, who conſequently have an overgrown *omentum*, are ſometimes troubled with an *epiplocele*

The *ſcrotum* is ſhorter and not ſo pendulous as the human, this it has in common with all the dog kind that want the *veſiculæ ſeminales*, who have it pretty cloſe tucked up, that the ſeed at each copulation might the ſooner be brought from the *teſtes*, thus in ſome meaſure ſupplying the place of the *veſiculæ ſeminales*; for the courſe of the ſeed through the *vaſa deferentia* is thus ſhortened by placing the ſecerning veſſels nearer the excretory organs. This at the ſame

ſame time explains the reaſon why this creature is ſo tedious in copulation.

The ſtructure of the *teſticles* is much the ſame with the human; as are likewiſe the *corpus pyramidale varicoſum* or *pampiniforme*, and the *epididymis* or excretory veſſel of the *teſticle*; the *vaſa deferentia* enter the *abdomen* where the blood veſſels come out, and paſſing along the upper part of the bladder, are inſerted a little below the bulbous part of the *urethra*.

The *præputium* has two muſcles fixed to it; one that ariſes from the *ſphincter ani*, and is inſerted all along the *penis*, and this is called *retractor præputii*; but the other, whoſe office is directly contrary to this, is cutaneous, and ſeems to take its origin from the muſcles of the *abdomen*, or rather to be a production of their *tunica carnoſa*. The *corpora cavernoſa* riſe much in the ſame way as the human; but theſe ſoon terminate, and the reſt is ſupplied by a triangular bone, in the inferior part of which there is a groove excavated for lodging the *urethra*. There are upon the *penis* two protuberant bulbous fleſhy ſubſtances, at the back of which are two veins, which by the *erectores penis* are compreſſed in the time of coition, and the circulation being ſtopt, the blood diſtends the large *cavernous* bodies: After the *penis* is thus ſwelled, the *vagina*, by its contraction, gripes it cloſely, and ſo the male is kept in action ſome time contrary to his will, till time be given for bringing a quantity of ſeed ſufficient to impregnate the female; and thus by that *orgaſmus veneris* of the female organs, the want of the *veſiculæ ſeminales* are in ſome meaſure ſupplied. But as it would be a very uneaſy poſture for the dog to ſupport himſelf ſolely upon his hinder feet, and for the bitch to ſupport the weight of the dog for ſo long a time; therefore as ſoon as the bulbous bodies are ſufficiently filled, he gets off and turns averſe to her; had then the *penis* been pliable as in other animals, the *urethra* muſt of neceſſity have been compreſſed by this twiſting, and

confequently the courfe of the feed intercepted ; but this is wifely provided againft by the *urethra*'s being formed in the hollow of the bone. After the emiffion of the feed, the parts turn flaccid, the circulation is reftored, and the bulbous parts can be eafily extended.

The *proftrata* feems here divided into two, which are proportionally larger than the human, and afford a greater quantity of that liquid.

The *uterus* of *multifarious* animals is little elfe but a continuation of their *vagina*, only feparated from it by a fmall ring or *valve*. From the *uterus* two long canals mount upon the loins, in which the *fœtus*'s are lodged ; thefe are divided into different *facs*, which are ftrongly conftricted betwixt each *fœtus*, yet thefe coarctions give way in the time of birth. From thefe go out the *tubæ fallopianæ*, fo that the *ovaria* come to lodge pretty near the kidneys.

We ought next to examine the ftructure of the *thorax* and its contents ; but firft it may not be amifs to remark of the *diaphragm* in its natural fituation, that it is in general more loofe and free than the human, which is owing to its connection with the neighbouring parts in a different manner from ours ; the human *diaphragm* is connected to the *pericardium*, which again by the intervention of the *mediaftinum* is tied to the *fternum*, *fpine*, &c. but here there is fome diftance between the *diaphragm* and *pericardium*. We obferve further that its middle part is much more moveable, and the tendinous parts not fo large. And indeed it was neceffary their *diaphragm* fhould be fomewhat loofe, they making more ufe of it in difficult refpiration than man. This we may obferve by the ftrong heaving of the flanks of an horfe or dog when out of breath ; which correfponds to the rifing of the ribs in us.

The difpofition and fituation of the *mammæ* vary as they bear one or more young. Thofe of the uniparous kind have them placed between the pofterior extremities, which in them is the higheft part of their

their bodies, whereby their young get at them without the inconvenience of kneeling; nevertheless, when the creatures are of no great size, and their breast large, as in sheep, the young ones are to take this posture. In multifarious animals they must have a great number of nipples, that their several young ones may have room at the same time, and these disposed over both *thorax* and *abdomen;* and the creatures generally lye down when their young are to be suckled, that they may give them the most favourable situation. From this it does not appear to be from any particular fitness of the vessels at certain places, for giving a proper nourishment to the child, that the breasts are so placed in women, as we find them, but really from that situation being the most convenient, both for mother and infant.

The *sternum* is very narrow, and consists of a great number of small bones, moveable every way, which always happens in creatures that have a great mobility in their *spine.* The ribs are streighter and by no means so convex as the human, whereby in respiration the motion forward will very little enlarge their *thorax*, which is compensated by the greater mobility of their *diaphragm*: so our *thorax* is principally enlarged according to its breadth and depth, and theirs according to its length. The want of *clavicles*, and the consequent falling in of the anterior extremities upon the chest, may contribute somewhat to the streightness of the ribs.

The *mediastinum* in this creature is pretty broad, whereas the human being so narrow has occasioned a dispute whether there be such a thing or not. The *pericardium* is not here contiguous to the *diaphragm*, but there is an inch of distance betwixt them, in which place the small lobe of the lungs lodges, and by this means the liver, &c. of this animal, though continually pressing upon the *diaphragm*, yet cannot disturb the heart's motion.

The heart is situated with its point almost directly downwards, according to the creature's posture, and

is but very little inclined to the left-ſide. Its point is much ſharper, and its ſhape more conoidal than the human. Here the names of right and left *ventricles* are proper enough, though not ſo in the human, which ought rather to be called anterior and poſterior, or ſuperior and inferior. The animal has the *vena cava* of a conſiderable length within the *thorax*, having near the whole length of the heart to run over ere it gets at the *ſinus lowerianus dexter*. In men, as ſoon as it pierces the *diaphragm*, ſo ſoon it enters the *pericardium*, which is firmly attached to it, and immediately gets into the *ſinus lowerianus*; which *ſinus* in the human ſubject, by the oblique ſituation of the heart, is almoſt contiguous to the *diaphragm*, and by this we diſcover that ſeveral authors have taken their delineations of the human heart from brutes, which is eaſily detected by the ſhape and ſituation of the heart, and long *vena cava* within the *thorax*. This was one of the faults of the curious wax-works, that were ſhewn at London and Paris, which was plainly taken from a cow.

This ſituation of the heart of the creature agrees beſt with the ſhape of its *thorax*, which is lower than the *abdomen*.

The egreſs of the large blood-veſſels from the heart is ſomewhat different from the human, for here the left *ſubclavian* comes off firſt, and then a large trunk runs ſome way upwards before it gives off the left *carotid*, and ſplits into the *carotid* and *ſubclavian* of the right ſide: So that neither here, properly ſpeaking, is there an *aorta aſcendens*, more than in the human, but this name has probably been impoſed upon it from obſerving this in a cow, where indeed there is an aſcending and deſcending *aorta*.

From this ſpeciality of the diſtribution of the veſſels of the right-ſide, which happens, though not in ſo great a degree, in the human ſubject, we may perhaps in ſome meaſure account for the general greater ſtrength, readineſs or faculty of motion which is obſervable in the right arm. I believe upon meaſuring

meaſuring the ſides of the veſſels, the ſurface of the united trunk of the right *ſubclavian* and *carotid* is leſs than that of the left *ſubclavian* and *carotid*, as they are ſeparated; if ſo, the reſiſtance to the blood muſt be leſs in that common trunk, than in the left *ſubclavian* and *carotid*; but if the reſiſtance be ſmaller, the abſolute force with which the blood is ſent from the heart being equal, there muſt neceſſarily be a greater quantity of blood ſent through them in a given time. And as the ſtrength of the muſcles is, *cæteris paribus*, as the quantity of blood ſent into them in a given time, thoſe of the right-arm will be ſtronger than thoſe of the left. Now children being conſcious of this ſuperior ſtrength, uſe the right upon all occaſions, and thus from uſe comes that great difference which is ſo obſervable. That this is a ſufficient cauſe ſeems evident from fact; for what a difference is there betwixt the right and left-arm of one who has played much at tennis? view but the arms of a blackſmith, and legs of a footman, and you'll ſoon be convinced of this effect ariſing from uſing them. But if by any accident the right-arm is kept from action for ſome time, the other from being uſed gets the better, and thoſe people are left handed: For it is not to be imagined that the ſmall odds in the original formation of the veſſels ſhould be ſufficient to reſiſt the effect of uſe and habit, (inſtances of the contrary occur every day;) 'tis enough for our preſent argument that where no means are uſed to oppoſe it, the odds are ſufficient to determine the choice in favour of the right. Now becauſe it is natural to begin with the leg correſponding to the hand we have moſt power of; this is what gives alſo a ſuperiority to the right leg.

This difference is not peculiar to man, but is ſtill more obſervable in thoſe creatures, in whom the ſame mechaniſm does obtain in a greater degree. Do but obſerve a dog at a trot, how he bears forwards with his right ſide, or look at him when a-ſcraping up any thing, and you will preſently ſee that he uſes his

right much oftner than he does his left-foot. Something analogous to this may be obſerved in horſes.

The *thymus* of this creature is proportionably much larger than ours, whereas the *glandula thyroidea* is much leſs, and it is generally remarked, that theſe two glands do thus always ſupply the place of each other: that is, in ſuch animals as have a large *thymus*; the *glandula thyroidea* is ſmaller, and *vice verſa*. Hence we are naturally led to aſcribe the ſame uſe to both, *viz.* the ſeparation of a thin *lymph* for diluting the *chyle* in the *thoracic duct*, before it be poured into the blood; then if we conſider the different formation of the *thorax* in both, we ſhall readily account for the variety in the bulk of theſe two glands. Reſpiration being chiefly performed in man by the widening of the cheſt, the lungs at every inſpiration muſt preſs upon the *thymus*, and conſequently diminiſh it; but the *diaphragm* yielding more in the dog's inſpiration, this gland is not ſo much preſſed by the lungs, and ſo will be larger, and hence the *glandula thyroidea* will be proportionably leſs: Again, from the poſture of this creature, we ſhall ſee that it was much more convenient for a dog to have the moſt part of the diluting *lymph* ſupplied by the *thymus*, ſince the neck being frequently in a deſcending poſture, the *lymph* of the *thyroid* gland would have a very diſadvantageous courſe to get to the *thoracic duct*: whereas in the human body, the *thymus* is really below the *lacteal* canal, where it makes its curvature before it opens into the *ſubclavian*, and conſequently there is a neceſſity of a conſiderable ſhare of the diluting liquor being furniſhed by the *thyroid* gland, which is ſituated much higher, ſo that its *lymph* has the advantage of a perpendicular deſcent.

We may here obſerve, that the *thoracic duct* in a dog has no curvature before it enters the *ſubclavian* vein. The horizontal poſition of this animal allowing a favourable enough courſe to the *chyle*, ſo as not to need that turn to force its paſſage into the blood. The lungs of this creature are divided into more numerous

merous lobes and deeper than they are in man, for the ſame reaſon as the liver. The left-ſide of the *thorax* in this animal bears a greater proportion to the right than in man, the one being nearly as three to two, the other as four to three.

We look on it as a general rule, that all *quadrupeds*, as having occaſion to gather their food from the ground, are provided with longer necks than man; but as a long neck not only gives the advantage of too long a *lever* to the weight of the head, but alſo when the animal is gathering his food, makes the brain in danger of being oppreſſed with too great a quantity of blood, by the liquor in theſe arteries having the advantage of a deſcent, while that in the veins muſt remount a conſiderable way contrary to its own gravity, it was therefore neceſſary that a part of the length of the neck ſhould be ſupplied by the length of the jaws. Thus we ſee horſes, cows, &c. who have no occaſion for opening their mouths very wide, yet have long jaws. Bull dogs indeed, and ſuch animals as have occaſion for very ſtrong jaws, muſt of neceſſity have them ſhort; becauſe the longer they are, the reſiſtance to be overcome acts with a longer *lever*. Another exception to this general rule is, ſuch animals as are furniſhed with ſomething analogous to hands to convey their food to their mouths, as cats, apes, *&c.* The *teeth* of this creature plainly ſhew it to be of the *carnivorous* kind, for there are none of them made for grinding their food, but only for tearing and dividing it. Even its poſterior *teeth* are not formed with rough broad ſurfaces as ours are; but are made conſiderably ſharper, and preſs over one another when the mouth is ſhut, that ſo they may take the firmer hold of whatever comes betwixt them.

The tongue, in conſequence of the length of the jaws, is much longer than ours; and as this creature feeds with his head in a depending poſture, the *bolus* would always be in danger of falling out of the mouth, were it not for ſeveral *prominences* placed moſtly

moſtly at the root of the tongue, and crooked backwards in ſuch a manner, as to allow any thing to preſs eaſily down to the jaws, but to hinder its return. In ſome animals who feed on living creatures, theſe under hooks are ſtill more conſpicuous, as in ſeveral large fiſhes, where they are almoſt as large as their *teeth* in the fore part of their mouth, and near as firm and ſtrong.

When we open the mouth, we ſee the *amygdals* very prominent in the poſterior part of it, ſo that it would appear at firſt view, that theſe were inconveniently placed, as being continually expoſed to injuries from the hard ſubſtances this creature ſwallows; but upon a more narrow ſcrutiny we find this provided for by two *membranous capſulæ*, into which the *amygdals*, when preſſed, can eſcape and remove themſelves from ſuch injuries.

The *velum pendulum palati*, is in this creature conſiderably longer than in man, to prevent the food from getting into his noſe; which would happen more frequently in this animal than in man, becauſe of its ſituation while feeding.

In this ſubject there is no *uvula*, but then the *epiglottis*, when preſt down, covers the whole *rima* entirely, and naturally continues ſo; there is therefore a *ligament* or rather muſcle that comes from the *os hyoides* and root of the tongue that is inſerted into that part of the *epiglottis*, where it is articulated with the *cricoid cartilage* which ſerves to raiſe it from the *rima*, though not ſo ſtrongly but that it may with a ſmall force be clapt down again. If then in all ſuch animals as have no *uvula*, the *epiglottis* is ſo ordered as to be capable of covering the *rima* entirely, and if in man the *epiglottis* cannot be ſo preſt backwards and downwards, as to ſhut up the *glottis* perfectly, but leaves a ſpace that can be exactly filled up by the *uvula*, we may very reaſonably conclude that the uſe of this part is to ſupply this deficiency in the *epiglottis*.

In

In the upper part of the *pharnyx*, behind the *cricoid cartilage*, there is a pretty large gland to be found, which ſerves not only for the ſeparation of a *mucous* liquor, to lubricate the *bolus* as it paſſes this way, but alſo ſupplies the place of a *valve*, to hinder the food from regurgitating into the mouth, which it would be apt to do by reaſon of the deſcending ſituation of the creature's head.

The *œſophagus* is formed pretty much in the ſame way as the human; authors indeed generally allege, that *quadrupeds* have their gullet compoſed of a double row of *ſpiral fibres* decuſſing one another, but this is proper to ruminating animals, who have occaſion for ſuch a decuſſation of *fibres*. The action of theſe you may eaſily obſerve in a cow chewing her cud.

The noſe is generally longer than in man, and its external paſſage much narrower. The internal ſtructure is alſo better adapted for an acute ſmelling, having a larger convoluted ſurface on which the *membrana ſcheideriana* is ſpread, and this is to be obſerved in moſt *quadrupeds*, who have the *oſſa ſpongioſa* commonly large, and theſe too divided into a great number of exceſſively fine thin *lamellæ*. The elephant, which has a head pretty large in proportion to its body, has the greateſt part of it taken up with the cavity of the noſe and *frontal ſinuſſes*, which laſt extend almoſt over their whole head, and leaves but a ſmall cavity for their brains. A very nice ſenſe of ſmelling was not ſo abſolutely neceſſary for man, who has judgment and experience to direct him in the choice of his food; whereas brutes, who have only their ſenſes, muſt have theſe of neceſſity acute, ſome having one ſenſe in greater perfection than others, according to their different way of life. We not only conclude *a priori* from the large expanded *membrana ſcheideriana* that their ſenſe of ſmelling is very acute, but we find it ſo by cows and horſes diſtinguiſhing ſo readily betwixt noxious and wholeſome herbs, which they do principally by this ſenſe.

The external ear in different *quadrupeds* is differently framed, but always calculated to the creature's manner of life: In ſhape it commonly reſembles the oblique ſection of a *cone* from near the *apex* to the baſis. Hares and ſuch other animals as are daily expoſed to inſults from beaſts of prey, have large ears directed backwards, their eyes warning them of any danger before; rapacious animals, on the other hand, have their ears placed directly forwards, as we ſee in the lion, cat, *&c.* The ſlow hounds and other animals that are deſigned to hear moſt diſtinctly the ſounds coming from below, have their ears hanging downwards. Man again, who muſt equally hear ſounds coming from all quarters, but eſpecially ſuch as are ſent from about his own height, has his external ear placed in a *vertical* manner, ſomewhat turned forward. In ſhort, wherever we ſee a ſpeciality in the make of this organ in any creature, we ſhall with very little reflection diſcover this form to be more convenient for that creature than another. There are ſome differences to be obſerved in the ſtructure of the internal ear in different animals; but we know ſo very little of the uſe of the particular parts of that organ in the human ſubject, that it is altogether impoſſible to aſſign reaſons for theſe variations in other creatures.

All *quadrupeds* have at the internal *canthus* of the eye, a ſtrong firm *membrane* with a *cartilaginous* edge, which may be made to cover ſome part of their eye, and this is greater or leſs in different animals, as their eyes are more or leſs expoſed to dangers in ſearching after their food: this *membrana nictitans,* as it is called, is not very large in this animal; cows and horſes have it ſo large as to cover one half of the eye like a curtain, and at the ſame time is tranſparent enough to allow abundance of the rays of light to paſs through it; fiſhes have a *cuticle* always over their eyes, as they are ever in danger in that inconſtant element. In this then we may alſo obſerve a ſort of gradation.

All

All *quadrupeds* have a ſeventh muſcle belonging to the eye, called *ſuſpenſorius*. It ſurrounds almoſt the whole *optic nerve*, and is fixed into the *ſclerotic* coat as the others are; its uſe is to ſuſtain the weight of the globule of the eye, and prevent the *optic nerve* being too much ſtretched, without obliging the four ſtraight muſcles to be in a continual contraction, which would be inconvenient. At the ſame time this muſcle may be brought to aſſiſt any of the other four, by cauſing one particular portion of it to act at a time.

The next thing to be remarked is the figure of the pupil, which is different in different animals, but always exactly accommodated to the creature's way of life. Man has it circular for obvious reaſons; an ox has it tranſverſe, to take in a larger view of his food; cats again have theirs ſomewhat perpendicular, (but can alter it pretty much) for a ſimilar reaſon, and ſo of the reſt: the pupil of different animals varies in wideneſs, according as the internal organs of viſion are more or leſs acute; thus cats and owls who ſeek their prey in the night, or in dark places, (and conſequently muſt have their eyes ſo formed as that a few rays of light may make a lively impreſſion on the *retina*), have their pupils in day time contracted into a very narrow ſpace, as a great number of rays would oppreſs their nice organs, while in the night they dilate conſiderably. In the ſame way when the *retina* is inflamed, a great number of rays of light would occaſion a painful ſenſation, therefore the pupil is contracted; on the contrary, in dying people, or in a beginning *amaurosis*, it is greatly dilated, as the eyes on ſuch occaſions are very difficultly affected, and as it were inſenſible.

The poſterior part of the *choroid* coat, which is called *tapetum*, is of different colours in different creatures. Oxen feeding moſtly on graſs have this *membrane* of a green colour, that it may reflect upon the *retina* all the rays of light which come from objects of that colour, while other rays are obſcured: thus the animal ſees its food better than other objects.

Cats and owls have their *tapetum* of a whitiſh colour, and for the ſame reaſons have the pupil very dilatable, and their organs of viſion acute; and we ſhall find that all animals ſee more or leſs diſtinctly in the dark, according as their *tapetum* approaches nearer to a white or black colour. Thus dogs who have it of a greyiſh colour diſtinguiſh objects better in the night than man, whoſe *tapetum* is dark brown, and who, I believe, ſees worſt in the dark of any creature, it being originally deſigned that he ſhould reſt from all kinds of employments in the night time. The difference then of the colour of the *tapetum*, as indeed the fabric of any other part in different creatures, always depends on ſome particular advantage accruing to the animal in its peculiar manner of life from this ſingularity.

We ſhall now proceed to the brain, which we remark in the firſt place is proportionally much ſmaller in all *quadrupeds* than the human. The reaſon of which may be, that as thoſe creatures for the moſt part ſeek their food with their heads in a depending poſture, this ſituation would make it very inconvenient for the brain itſelf to ſend its animal ſpirits (or its influence and energy, let that be what it will) through the nerves, ſo that it was neceſſary they ſhould be ſupplied from ſomewhere elſe, and conſequently there was no reaſon for the brain itſelf being of a great bulk. As a confirmation of this theory, we find that the *intercoſtal* and eight pair of nerves, which ſerve the vital organs in the human body, take their origin from the *encephalon*, which in *quadrupeds* come moſtly from the *theca vertebrarum*. Again, there was no ſuch occaſion for ſo great a quantity of brains in thoſe animals as in man; ſeeing in them all its energy is employed in their progreſſion, while man has great waſte of ſpirits in the exerciſe of his reaſon and intellectual faculties. And beſides all this, a great bulky brain would be inconvenient to theſe creatures, in ſo far as it would add conſiderably to the weight of the head, which having the advantage of

a long *lever* to act with, would require a much greater force to support it than now it does; for the heads of the greatest parts of *quadrupeds* are not near so heavy as they would at sight seem to be, from the *sinus frontales* being produced a great way upwards to enlarge the organs of smelling.

The pits in the anterior part of their skulls are much more conspicuous than in the human *cranium*, which may be occasioned by the depending posture of these creatures heads, while they gather their food: The brain at this time gravitating much on the bones while they are as yet soft, will gradually make impressions upon them at these places where it rises into eminencies. This is prevented in man mostly by his erect posture.

The *falx* is not near so large in *quadrupeds* as in man, as they have little occasion to be on either side, and the two *hemispheres* of the brain are in a great measure hindered from justling against one another in violent motions, by the brain's insinuating itself into the above-mentioned pits.

The second process of the *dura mater*, or *tentorium cerebello superexpansum*, is considerably thicker and stronger in most *quadrupeds* than in man, especially in such of them as are very swift of foot, as hares and rabbits, and that most when they are old. This membrane is generally ossified, that it may the more effectually keep off the weight of the superincumbent brain from the *cerebellum* in their rapid motions, which otherwise would be of bad consequence.

The olfactory nerves are very large, and justl deserve the name of *processus mamillaris*. They are hollow, and consist of a *medullary* and *cineritious* substance, and at first sight appear to be anterior ventricles of the brain produced; but in man they are small, and without any discernable cavity. The reason of this is pretty evident, if we consider how this animal's head is situated; for the *lymph* continually gravitating upon the inferior part of the *ventricles* may thus elongate and produce them: But from this

very inferior part the *olfactory nerves* riſe, and are ſent immediately through the *os ethmoides* into the noſe. Hence the antients thinking they were continued hollow into the noſe, believed they were the *emunctories* of the brain; in the brain of ſheep, which by its firm texture is the beſt ſubject of any for ſearching into the ſtructure of this part, we evidently ſee, that the name of the *ſigmoid* cavities was very properly applied by the antients to the lateral ventricles of the brain, which are really of a greater extent than they are ordinarily painted by the anatomiſts, reaching farther backwards and forwards again under the ſubſtance of the brain.

The *nates* and *teſtes* deſerve this name much better here than in the human body with reſpect to each other. They are here alſo of different colours, the *nates* being of the colour of the *cortical*, and the *teſtes* of the *medullary* ſubſtance of the brain: Whereas in man they are both of one colour. The reaſon of theſe differences, and others of the like nature to be met with, I ſhall not pretend to determine; for we have hitherto ſuch an imperfect knowledge of the brain itſelf, that we are entirely ignorant of the various uſes of its different parts; we may in general conclude, that the varying in one animal, from what it is in another, is fitted to the creature's particular way of living.

The *rete mirabile galeni*, ſituated on each ſide of the *ſella turcica*, about which there has been ſo much diſpute, is more remarkable in *quadrupeds* than in the human ſubject, though it is certainly to be found there too; notwithſtanding ſeveral anatomiſts have denied its exiſtence. The uſe indeed which Galen aſcribes to it is frivolous and not well grounded; for he will have this *plexus* of the veſſels ſerve for checking the impetuoſity of the brain, but it is evident this cannot be the uſe of it; if indeed the whole *carotid artery* had ſplit into ſuch ſmall veſſels as compoſe this network, the motion of the blood would certainly have been retarded in it; but this is not the caſe, for it only

only ſends off a few ſmall twigs to compoſe the *plexus* at its entry into the *cranium*, and the branches going out from this ſame *plexus*, are diſtributed to the neighbouring nerves: Among the reſt it gives ſome twigs to the *ophthalmic* branch of the fifth pair. It is this diſtribution of theſe arteries makes it ſo difficult to determine whether there is a communication between the *intercoſtal* and that nerve; for if you diſſect the parts in a recent ſubject, you would at firſt view affirm, that there is an *anaſtomoſis*; but when the *carotid artery* is injected, and the *plexus* filled with the ſubtile liquor, theſe branches, which formerly ſeemed to be nerves, have now the appearance of arteries by the veſſels of their coats being injected. I have been at great pains to enquire into the matter, but could never poſitively determine if there is ſuch an *anaſtomoſis* as is deſcribed by a great many authors, and ſo very diſtinctly delineated by Dr Lower in Willis's treatiſe of the nerves, and Mr Vieuſſen, only it ſeems moſt probable from the ſympathy obſervable between them that there is ſuch an *anaſtomoſis*.

The ſtructure of the brain differing but very little in all *quadrupeds*, it will be needleſs to examine it in any other.

The Anatomy of a Cow.

THE next ſpecies of *quadrupeds* we propoſed to conſider was the ruminant kind, of which we have an example in a cow, and accordingly ſhall take the *fœtus* of the animal in *utero*, that we may firſt remark ſome things that are peculiar to it in that ſtate, and afterwards proceed to examine its *viſcera* as a ruminant animal; firſt then as a *fœtus*:

The form of a cow's *uterus* differs from the human, in having two pretty large *cornua*. This is common to it with other brutes, for a bitch has two long *cornua uteri*; but theſe again differ (as being *multiparous*

parous and *uniparous*) in this, that in the bitch's *cornua* the *fœtus's* are contained, whereas here there is only part of the *fecundines*, being moſtly the *allantois* with the included liquor. The muſcular fibres of the *uterus* are more eaſily diſcovered; its internal ſurface has a great number of ſpungy, oblong, protuberant, glandular bodies fixed to it by a fine *membrane*: Theſe are compoſed of ſeveral large veſſels of the *uterus* terminating here. Theſe are very ſmall, and ſometimes not to be obſerved at all. In an impregnated *uterus* we can eaſily preſs out of them a *chylous mucilaginous* liquor; they are compoſed of a great many proceſſes or *digituli*, and deep caverns anſwering to as many proceſſes and caverns of the *placenta*. Their reſemblance has occaſioned the name of *papillæ* to be given them, and hence it was that Hippocrates was induced to believe, that the *fœtus* ſuck'd in *utero*. It is not eaſy to determine, whether the *uterus* grows thicker or thinner in the time of geſtation. The *membranes* it is plain (by the ſtretching of the parts) muſt be made thinner, but then it is as evident, that the veſſels are at that time enlarged, upon which principally the thickneſs of any part depends; ſo there ſeems to be as much gained the one way, as loſt the other. The *os uteri* is entirely ſhut up by a glutinous mucilaginous ſubſtance, that is common to the females of all creatures when with young; by this the external air is excluded, which would ſoon make the liquors corrupt; it alſo prevents the inflammation of the *membranes*, and the hazard of abortion. By this means alſo the lips of the womb are kept from growing together, which otherwiſe they would certainly at this time do. There are *mucous* glands placed here to ſecern this *gluten*, which on the breaking of the *membranes* with the contained waters make a *ſapo* that lubricates and waſhes the parts, and makes them eaſily yield. The firſt of the proper *involucra* of the *fœtus* is the *chorion*.

The *chorion* is a pretty ſtrong firm *membrane*, on whoſe external ſurface are diſperſed a great many red

fleſhy

flefhy bodies of the fame number, fize and ftructure with the *papillæ*, with which they are mutually indented. They have been called *cotyledones* from κοτύλη cavity. This is greatly difputed by fome as a name very improper, but I think without reafon, fince the furface that is connected to the *papillæ* is concave, though when feparated it appears rather convex. To fhun all difpute, they may be called properly enough *placentulæ*, fince they ferve the fame ufe as the *placenta* in women. The feparation of thefe from the *papillæ* without any dilaceration feems to prove beyond a reply, that there can be here no *anaftomofes* betwixt the veffels; on their coats run a great number of veffels that are fent to the feveral *placentulæ*, on the external fide next to the *uterus;* whereas in creatures that have but one *placenta*, as in the human fubject, cats, dogs, *&c.* the adhefion is fomewhat firmer: The *placentæ* are likewife joined to the *papillæ* in the *cornua uteri*. We fhall next give the hiftory of the *allantois*.

This is a fine tranfparent *membrane* contiguous to the former. It is not a general *involucrum* of the *fœtus* in the mother, for it covers only a fmall part of the *amnios:* It is moftly lodged in the *cornua uteri*. In mares, bitches and cats it furrounds the *amnios*, being every where interpofed betwixt it and the *chorion*. In fheep and goats it is the fame as in this animal; and in fwine and rabbits it covers ftill lefs of the *amnios*. This fac is probably formed by the dilatation of the *urachus*, which is connected at its other end to the *fundus* of the bladder, through which it receives its contents, and the *membrane* is doubled at the extremity of the canal to hinder the return of the urine back into the bladder. Its veffels are exceffively fine and few, and we cannot force an injected liquor farther than the beginning of this coat. This *membrane* is fo far analogous to the *cuticula*, as not to be liable to corruption, or eafily irritated by acrid liquors. The exiftence of this *membrane* in women has been very warmly difputed on

both

both ſides: Thoſe who are againſt its exiſtence deny they could ever find it, and allowing it were ſo, allege, that ſince the *urachus* is impervious, as appears by our not being able to throw liquors from the bladder into it, or *vice verſa*, it cannot ſerve the uſe that is agreed by all it does ſerve in beaſts, and therefore in the human body there is no ſuch thing: But if we conſider on the other hand, that firſt there ſeems to be the ſame neceſſity for ſuch a reſervoir in man as in other animals Secondly, that we actually find urine contained in the bladder of the human *fœtus*. Thirdly, that urine has been evacuated at the navel when the *urethra* was ſtopped, which urine without this conduit would have fallen into the cavity of the *abdomen*. Fourthly, that midwives do generally remark two different ſorts of waters come away at the time of birth. And, laſtly, that Dr Littre and Dr Hale have given in this *membrane* of an human ſubject with all the other ſecundines curiouſly prepared, the one to the Royal Academy at Paris, the other to the Royal Society at London, by which ſocieties their reſpective accounts are atteſted, not to mention Verheyen, Heiſter, Keil, *&c.* who affirm their having ſeen it, and Mr Albinus, that famous anatomiſt, profeſſor at Leyden, ſhows, as I am told, to his college every year a preparation of it. On all theſe accounts I muſt own, that it ſeems moſt probable to me there is ſuch a *membrane* in the human body, although in four bodies I purpoſely diſſected, wherein I was aſſiſted by a very accurate anatomiſt, Dr S———r, I could not obſerve any ſuch thing; however, I would rather accuſe my own want of ſkill, than doubt the truth of relations ſupported by ſuch authentic vouchers.

The third proper integument of the *fœtus* is the *amnios*; it is thinner and firmer than the *chorion*; it has numerous ramifications of the umbilical veſſels ſpread upon it, the lateral branches of which ſeparate a liquor into its cavity. This is the proper liquor

quor of the *amnios*, which at firſt is in a ſmall quantity, afterwards encreaſes for ſome months, then again decreaſes; and in a cow near her time the quantity of this liquor is not above a pound. This *membrane* does not enter the *cornua uteri* in this creature; but for what further relates to the ſtructure of the *involucra*, with the nature of the liquors contained in them, I muſt refer to the ſecond volume of medical eſſays, from page 121, where you have the ſum of all we know of this matter.

There are here two *venæ umbilicales*, and but one in the human ſubject, becauſe the extreme branches coming from the ſeveral *placentulæ* could not unite ſo ſoon as they would have done had they come all from one cake, as in the human.

There is a ſmall round fleſhy body that ſwims in the urine of this creature, mares, &c. called *cuticula*, which is the *hypomenes* of the ancients. Several idle opinions and whims have been entertained as to its uſe, but that ſeems to be ſtill unknown, or how it is generated or nouriſhed, for it has no connection with the *fœtus* or *placentulæ*.

Having thus conſidered the ſeveral *involucra* of this animal in a *fœtus* ſtate, let us next obſerve the ſpecialities in its internal ſtructure peculiar to a *fœtus*.

The umbilical vein joins the *vena portarum* in the *capſula gliſſoniana* without ſending off any branches as it does in the human ſubject. This vein ſoon after birth turns to a ligament, yet there are ſome inſtances where it has remained pervious for ſeveral years after birth, and occaſioned an hemorrhage. We may next obſerve the duct called *canalis venoſus*, going ſtreight from the *capſula gliſſoniana* to the *vena cava*; this turns alſo afterwards to a ligament. The umbilical arteries riſe at acute angles from the internal iliacs, whatever ſome may ſay to the contrary: Theſe alſo become impervious.

The pulmonary artery coming from the right ventricle of the heart, divides into two, the ſmalleſt called

called *canalis arteriosus* opens into the descending *aorta*; the other divides into two, to serve the lungs on each side. The *foramen ovale* is placed in the partition betwixt the right and left auricles. At the edge of this hole is fixed a *membrane*, which when much stretched will cover it all over, but more easily yields to a force that acts from the right auricle to the left, than from the left to the right. After what has been said we may easily understand how the circulation is performed in a *fœtus*. The blood being brought from the *placenta* of the mother, is thrown into the *capsula glissoniana*, where it is intimately blended with the blood in the *vena portarum*: then part of this blood goes directly into the *vena cava* by the *ductus venosus*, the rest passes through the liver. First then, the whole is sent from the *vena cava* into the right *auricle*, from whence part of it is sent by the *foramen ovale* into the left *auricle*, the rest passes into the right ventricle, then into the *pulmonary* artery, then the greatest share it receives is sent immediately into the descending *aorta* by the *canalis arteriosus*, and the remainder circulates through the lungs and is sent back by the *pulmonary* veins into the left *auricle*, which with the blood brought there by the *foramen ovale* is sent into the left ventricle, from whence it is driven by the *aorta* through the body. The great design of this mechanism is, that the whole mass of blood might not pass through the collapsed lungs of the *fœtus*, but that part of it might pass through the *foramen ovale* and *canalis arteriosus* without circulating at all through the lungs.

This was the opinion that universally prevailed till the end of the last century, when it was violently opposed by Monsieur Mery, who is very singular in several of his opinions. He will not allow that the *foramen ovale* transmits blood from the right to the left *auricle*, but, on the contrary, from the left to the right, and that for no other reason but because he observed the *pulmonary* artery in a *fœtus* longer

longer than the *aorta:* Mr Winſlow endeavours to reconcile theſe two opinions, by ſaying the blood may paſs either way, and that it is here as it were blended; his reaſon is, that on putting the heart in water, the *foramen ovale* tranſmits it any way. Mr Rohault, profeſſor of anatomy at Turin, and formerly one of Mery's ſcholars, ſtrongly defends his maſter and criticiſes Mr Winſlow. What he principally builds on is the appearance this *foramen* has in ſome dried preparations: This Mr Winſlow won't allow as a proof. After all I remain in the common opinion, and that for the following reaſons: Firſt, the *pulmonary* artery being larger ſignifies nothing, ſince its coats are not only thinner, and will be more eaſily diſtended, but alſo the reſiſtance to the blood in the *pulmonary* artery from the collapſed lungs is greater than the reſiſtance to the blood in the *aorta.* Secondly, if we ſhould allow any of theſe two uncommon opinions, we ſhould have the right ventricle vaſtly more capacious than the left; for if we ſuppoſe the *foramen ovale* to be capable of tranſmitting one half of the whole maſs of blood in any given time, and the *arterioſus* as much in the ſame time, then you'll find that, according to Mr Mery's opinion, the whole maſs of blood being driven from the right ventricle into the *pulmonary* artery, one third paſſes by the *canalis arterioſus* into the deſcending *aorta,* two thirds paſſing through the lungs and returning into the left *auricle,* one half of it, or one third of the whole maſs, paſſes by the *foramen ovale* into the right *auricle,* and the other or the laſt third will be ſent into the left ventricle, and thence expelled into the *aorta,* which third, with that from the *pulmonary* artery by the *canalis arterioſus,* circulating through the body, are returned unto the right *auricle,* where meeting with the other third from the *foramen ovale,* with it are ſent into the right ventricle to undergo the ſame courſe. Thus the whole maſs is expelled by the right ventricle and only one third by the left. If

was the caſe, why is not the right ventricle three times as large and ſtrong as the left? Then if according to Mr Winſlow's ſyſtem the *foramen ovale* tranſmits equal quantities from both *auricles*, this comes to the ſame as if there were no *foramen ovale* at all; that is to ſay, the whole maſs going from the right *auricle* into the right ventricle and *pulmonary* artery, one third of the whole maſs paſſes into the *aorta* through the *canalis arterioſus*, the other two thirds paſſing through the lungs return to the left ventricle and *auricle*, to be ſent through the *canalis arterioſus* to the right ventricle to undergo the ſame fate; thus the right ventricle expels the whole maſs, the left only one third; but if according to the common opinion we ſuppoſe the *foramen ovale* to convey the blood from the right to the left *auricle*, then one third paſſes this way into the left ventricle, the other two thirds are ſent by the right ventricle into the *pulmonary* artery, from whence one third paſſes by the *canalis arterioſus* into the *aorta deſcendens*, the other third circulates through the lungs, and is returned into the left ventricle, where meeting with that from the *foramen ovale* is with it expelled into the *aorta*, and with the one third tranſmitted by the *canalis arterioſus* returns into the *auricle* to run the ſame race as before. Thus we conclude that two thirds are expelled by each ventricle and the whole circulates through the body; and hence they come to be of pretty equal dimenſions. In all this calculation I have had no regard to the blood diſcharged from the *umbilical* veſſels; but the greater quantity returned by the veins, than ſent out by the arteries, ſtill argues for the common opinion.

The kidneys in the *fœtus* are compoſed of different lobes, which ſerves to give us an idea of the kidneys being a congeries of different glands; theſe lobes being kept contiguous by the external *membrane* are preſſed by the other *viſcera* till at length they unite.

We

We come now to confider the creature as a ruminant animal. There are no *dentes incifores* in the upper jaw, but the gums are pretty hard, their tongue rough, and they fupply this defect by wrapping their tongue round a tuft of grafs, fo preffing it againft the upper jaw keep it ftretched, and cut it with the teeth of the under jaw; then, without chewing, throw it down into the *œfophagus*, which, in thefe creatures, confifts of a double row of *fpiral fibres* decuffating one another. All animals which ruminate muft have more ventricles than one, fome two, fome three, our prefent fubject has no lefs than four. The food is carried directly down into the firft, which lies upon the left fide and is the largeft of all; it is called *γάστηρ ventriculus*, and *κοιλία* by way of eminence. It is what is called by the general name of paunch by the vulgar. There are no *rugæ* upon its internal furface; the food, by the force of its mufcular coat, and the liquors poured in here, is fufficiently macerated, after which it is forced up hence by the *œfophagus* into the mouth, and there it is made very fmall by maftication; this is what is properly called chewing the cud or rumination; after this it is fent down by the gullet into the fecond, for the *œfophagus* opens indifferently into both; however the creature has a power to direct it into which it will. Some tell us that the drink goes into the fecond, but that might be eafily determined by making them drink before flaughter; the fecond ftomach, which is the anterior and fmalleft, is called *κεκρύφαλος reticulum*, the *bonnet*, or *king's-hood*. It confifts of a great number of cells on its internal furface of a regular *pentagonal* figure, like to a honeycomb. Here the food is farther macerated, from which it is protruded into the third, called *εχῖνος* or *omafum*, *vulgo* the *manyplus*, becaufe the internal furface rifes up into a great many *plicæ* or folds, and *ftratum fuper ftratum*, according to the length of this ftomach. Some of thefe *plicæ* are further produced into the ftomach than others, *i. e.* firft two long ones

ones on each ſide, and within theſe, two ſhorter in the middle, *&c.* There are ſeveral glands in this ſtomach which is next to the κοιλια in bigneſs, and from this it paſſes into the fourth, whoſe names are, ἤνυστρον *abomaſum, caille,* or the *red,* which is the name it commonly has becauſe of its colour. *Caille* ſignifies curdled, and hence the French have given that as a name to this fourth ſtomach, becauſe any milk that is taken down by young calves, from the long *remora* it makes here, turns acid; and by the remains of the milk before taken down aſſiſting, it is curdled. It is this fourth ſtomach with the milk curdled in it, that is commonly taken for earning of milk (as they call it), but after the *bile* and *pancreatic* juice enter, this coagulation is not to be found which ſhews the uſe of theſe liquors. There are other creatures that uſe the ſame food, that have not ſuch a mechaniſm in their digeſtive organs; horſes, aſſes, *&c.* have but one ſtomach where graſs is macerated, and a liquor for their nouriſhment extracted, and the remainder ſent out by the *anus* very little altered. From this different ſtructure of the ſtomach in theſe creatures, a ruminant animal will be ſerved with one third leſs food than another of equal bulk; graſiers are ſufficiently acquainted with this. The reaſon is, that ruminating animals have many and ſtrong digeſtive organs; all their food is fully prepared and almoſt wholly converted into *chyle,* but a horſe's ſtomach is not fitted for this, ſo that they require a much greater quantity of food to extract the ſame nouriſhment.

The guts of theſe creatures are of a conſiderable length in proportion to the bulk of the animal's body, and this confirms what we ſaid formerly on the ſubject of the *inteſtines* of a dog, *viz.* that the length and capacity of the guts were different in different animals according to the nature of their food.

The *duodenum* is formed here much the ſame way as in a dog, and the general intention kept in view with regard to the mixture of the *bile* and *pancreatic*

tic lymph. The great guts here hardly deſerve that name, their diameter differing very little from that of the ſmall ones; but to compenſate this, they are much longer proportionally than a dog's are, being convoluted in the ſame way as the ſmall guts are. The *cæcum* is very large.

The *ſpleen* differs not much either in figure or ſituation from that of a dog's, but it is a little more firmly fixed to the *diaphragm*, there not being here ſo much danger of this *viſcus*'s being hurt in the *flexions* of the *ſpine*.

The *liver* is not ſplit into ſo many *lobes* in this creature as either in a man or dog, which depends on the ſmall motion this creature enjoys in its *ſpine*, which made ſuch a diviſion needleſs: This alſo confirms what I formerly advanced on this head.

Their *veſica urinaria* is of a pyramidal ſhape, and has ſcarce any *muſcular fibres*. It is very large and membranaceous, for the urine of theſe creatures not being ſo acrid as that of *carnivorous* animals, there was no ſuch occaſion for expelling it ſo ſoon.

This creature is provided with a looſe pendulous *ſcrotum*, and conſequently with *veſiculæ ſeminales*. The female organs differ from thoſe of a bitch, moſtly as to the form of the *cornua uteri*, which are here converted in form of a ſnail. In this and all uniparous animals they contain only part of the *ſecundines*, but in bitches and other multiparous animals they run ſtreight up in the *abdomen*, and contain the *fœtus* themſelves.

The ſituation of the heart is pretty much the ſame with that of a dog, only its point is rather ſharper; in us the heart beating continually againſt the ribs, and both *ventricles* going equally far down to the conſtitution of the *apex* it is very obtuſe, but here the *apex* is made up only of the left *ventricle*, ſo is more acute.

The *aorta* in this creature is juſtly divided into aſcending and deſcending; though this diviſion is ill founded either in a dog or man, and it has certainly

been from this ſubject that the older anatomiſts took their deſcriptions when they made this diviſion; for here the *aorta* divides into two, the aſcending and deſcending; the deſcending runs upwards or forwards, according to their poſture, for two or three inches, before it gives off the left *ſubclavian*, and ſtill an inch or more before the right *ſubclavian* comes off, and yet ſomewhat further before it divides into the two *carotids*, ſo that the veſſels that go to the anterior extremity of the right-ſide, do ſtill keep longer in a common trunk with the *carotids* than thoſe on the left.

Of Fowls in general.

THE next claſs of animals we come to conſider, are the feathered kind; which are divided into the *Granivorous* and *Carnivorous*. But before we go on to conſider the ſpecialties in the *viſcera* of each kind, we muſt obſerve what both ſpecies agree in.

Fowls have a particular covering of *feathers* different from all other creatures, but exactly well ſuited to their manner of life; for it not only protects them from the injuries of the weather, but ſerves them in their progreſſion through that thin aerial element, they are for the moſt part employed in; and as ſome fowls live much in the water, their feathers being continually beſmeared with an oily liquor, keeps the water from ſoaking into their ſkins, and ſo prevents its bad effects, which it would infallibly otherwiſe produce.

Fowls have the ſtrongeſt muſcles of their whole body inſerted into their wings; whence by the way we may obſerve that it is altogether impoſſible for man to buoy himſelf up into the air like birds, even though he had proper machines in place of wings, unleſs he were likewiſe provided with muſcles ſtrong enough for moving them, which he has not. In the next place their wings are not placed in the middle of

of their bodies, but a good deal further forwards, whence it would at firſt view appear that their heads would be erect, and their poſterior parts moſt depending, when raiſed in the air; but by ſtretching out their heads, which act upon the *lever* of a long neck, they alter their center of gravity pretty much, and alſo by filling the ſacs or bladders in the inſide of their *abdomen*, with air, and expanding their tail, they come to make the poſterior part of their bodies conſiderably higher, and thus they fly with their bodies near in an horizontal ſituation. Hence we find, that if their necks are kept from being ſtretched out, or if you cut away their tails, they become incapable of flying any conſiderable way. The largeneſs of the wings in different fowls varies, according to the occaſions of the creature. Thus birds of prey, who muſt fly a conſiderably way to provide their food, have large ſtrong wings; whereas domeſtic birds, who find their nouriſhment almoſt every where, have very ſhort and but ſmall wings. The beſt account of the manner of progreſſion of fowls, is given by Alfonſus Borellus, in his treatiſe De Motu Animalium, and in the Religious Philoſopher we have Borelli's doctrine ſtripped pretty much of its mathematical form. The poſterior extremities are ſo ſituated as to make us at firſt think they would be in continual hazard of falling down forwards when they walk, but this is prevented by their holding up their heads and necks, and when they have occaſion for climbing up a ſteep place, they ſtretch out their heads and necks forwards. Thus we may obſerve a gooſe entering a barn-door, where generally there is an aſcending ſtep, to ſtretch out its neck, which before was raiſed, and incline its body forwards; this is laughed at by the common people, who aſcribe it to a piece of folly in the gooſe, as if afraid of knocking its head againſt the top of the door.

Carnivorous animals are provided with ſtrong crooked claws for the catching their prey; water fowls uſe them for ſwimming, and principally for this purpoſe have a ſtrong firm *membrane* interpoſed betwixt

twixt the toes. There is a beautiful mechanifm to be obferved in the toes of fowls, which is of confiderable ufe to them; for their toes are naturally drawn together or bended when the foot is bended; this perhaps proceeds from the tendons of the toes paffing over in them, which is analogous to our heels, and when the foot is bended muft confequently be much ftretched; and fince they are inferted into the toes, muft, of neceffity bend them when the foot is bended, and when the foot is extended the *flexors* of the toes are again relaxed, and they therefore expanded. This is of great ufe to water fowls, for had there been no fuch contrivance as this, they muft have loft as much time when they pulled their legs in, as they had gained by the former ftroke; but as the parts are now framed, whenever the creature draws in its foot, the toes are at the fame time bended and contracted into lefs fpace, fo that the refiftance made againft the water is not near fo great as before: On the contrary, when they ftretch their foot, their toes are extended, the *membrane* betwixt them expanded, and confequently a greater refiftance made to the water. Again, fuch fowls as live moftly in the air, or have occafion to fuftain themfelves on branches of trees in windy weather, and even in the night-time when afleep, while all their mufcles are fuppofed to be in a ftate of relaxation; fuch, I fay, have no more to do, but lean down the weight of their bodies, and their toes continue bended without any mufcles being in action; and whenever they would difentangle themfelves, they raife up their bodies, by which their foot, and confequently their toes, are extended.

Carnivorous fowls have their beaks long, fharp and crooked; the domeftic fowls, fuch as the hen kind, *&c.* have ftrong fhort beaks, commodioufly fitted to dig up and break their food; the water fowls again have long or very broad fcoop-like beaks, which is moft convenient for them. The *fternum* of fowls is much larger proportionally than the human, and has a

a ridge riſing in its middle for the more commodious origin of the muſcles that move the wings. It is alſo leſs moveable than ours, for had it been very moveable, a great deal of the force employed for moving the wings would at every contraction of the muſcles have been loſt, or elſe ſome other muſcles muſt have come in play to keep firm the *ſternum*, but this additional weight would have been inconvenient for their progreſſion.

What other things are moſt remarkable in the ſtructure of the ſeveral *viſcera*, we ſhall conſider in that common domeſtic animal, the cock or hen, and afterwards obſerve the difference of their *viſcera chylopcietica* from a *carnivorous* fowl.

The Anatomy of a Cock.

THE *oeſophagus* of this creature runs down its neck ſomewhat inclined to the right-ſide, and terminates in a pretty large *membranous ſac*, which is the *ingluvies* or crop where the food is macerated and diſſolved by a liquor, ſeparated by the glands which are eaſily obſerved every where on the external ſurface of this bag. The effect of this maceration may be very well obſerved in pigeons, who are ſometimes in danger of being ſuffocated by the peaſe, &c. they feed upon, ſwelling to ſuch an immenſe bulk in their *ingluvies*, that they can neither get upwards nor downwards. If it be a favourite fowl, it might be preſerved by opening the *ſac*, taking out the peaſe and ſewing up the wound.

The food getting out of this *ſac* goes down by the remaining part of the *œſophagus* into the *ventriculus ſuccenturiatus* or *infundibulum peyeri*, which is a continuation of the gullet with more numerous glands, which ſeparate a liquor to dilute the food ſtill more, which at length gets into the true ſtomach or gizzard, which conſiſts of two very ſtrong muſcles covered externally with a *tendinous aponeuroſis*, and lined

on

on the inſide by a very thick firm *membrane*, which we evidently diſcover to be a production of the *cuticula*. This might have been proved in ſome meaſure *a priori*, from taking notice that this *membrane*, which in chicks is only a thin ſlight *pellicle*, by degrees turns thicker and ſtronger, the more attrition it ſuffers : but there is no other animal ſubſtance, ſo far as we know, which grows more hard and thick by being ſubjected to attrition, excepting the *cuticula*. Hence may be drawn ſome kind of proof of what I have ſometimes affirmed concerning the *tunica villoſa* of the ſtomach, and *inteſtines* in the human body, *viz*. that it was only a continuation of the *epidermis*. Nay, all the hollow parts of the body, even arteries, veins, &c. ſeem to be lined with a production of this *membrane* or one *analogous* to it. The uſe of this internal coat of the ſtomach of fowls is to defend the more tender parts of that *viſcus* from the hard grains and little ſtones thoſe creatures take down.

The digeſtion of theſe animals is performed merely by attrition, as is evinced by many experiments. We ſee them daily take down conſiderable numbers of the moſt ſolid rugged little flints they find, and theſe can ſerve for no other purpoſe than to help the trituration of their aliments. After theſe pebbles by becoming ſmooth are unfit for this office, they are thrown up by the mouth ; hence fowls that are long confined, though never ſo well fed, turn lean for want of theſe ſtones to help their digeſtion ; but this was put beyond all diſpute by Mr Tauvry, who gave a ſpecies of metal to an oſtrich, convex on one ſide, and concave on the other, but carved on both ; and opening the creature's body ſome time after, it was found that the carving on the convex ſide was all obliterated, while the engraved character remained the ſame as before on the concave ſide, which was not ſubjected to the ſtomach's preſſure ; which could not have happened had digeſtion been performed by a *menſtruum*, or any other way whatſoever; but may be eaſily ſolved by allowing a ſimple mechanical preſſure

preſſure to take place. We are however by no means to conclude from this, as ſome have too raſhly done, that in the human body digeſtion is performed by a ſimple attrition, otherwiſe we may with equal ſtrength of reaſon, by as good arguments drawn from what is obſerved in fiſhes, prove that the aliments are diſſolved in our ſtomachs by the action of a *menſtruum*: But this method of reaſoning is very faulty, nor can it ever bring us to the true ſolution of any philoſophical or medical problem. It is very plain, ſince the ſtructure of the parts of the human ſtomach are ſo very different from that of this creature, that it is fooliſh and unreaſonable to imagine both of hem capable of producing the ſame effects At each end of the ſtomach there are as it were two particular ſacs of a different texture from the reſt of the ſtomach, not conſiſting of ſtrong *muſcular fibres*; they ſeem to be receptacles for the ſtones (eſpecially at the end which is fartheſt from the orifice) while the digeſted aliment is protruded into the *inteſtines*.

The *duodenum* begins pretty near the ſame place, at which the *œſophagus* enters; yet notwithſtanding the vicinity of theſe two tubes, the aliments are in no danger of getting out before they are perfectly digeſted, by reaſon of a protuberance or *ſeptum medium* betwixt the orifices; and in thoſe creatures who have ſuch a ſtrong muſcular ſtomach, it is a matter of great indifference, whether the entry of the *œſophagus* or *pylorus* be higheſt, provided that the entry from the *œſophagus* does not allow the food to regurgitate, ſince the force of the ſtomach can eaſily protrude it towards the *duodenum*. This gut is moſtly in the right ſide, and hangs pendulous in their *abdomen*, having its two extremities fixed to the liver. The *ductus communis choledochus* enters near its termination, where it mounts up again to be fixed to the liver; and leſt, by the contraction of the *inteſtines*, the *bile* ſhould paſs over without being intimately blended with the *chyle*, that *duct* enters downwards contrary to the courſe of the food, and contrary to what is obſerved

in

in any of the animals we have mentioned yet. But ſtill the general intention is kept in view, in allowing theſe juices the faireſt chance of being intimately blended with the food.

The ſmall guts are proportionally larger than thoſe of *carnivorous* birds, for the general cauſe already aſſigned. At the end of the *ilium* they have two large *inteſtina cæca*, one on each ſide, which ſerve as reſervoirs to the *fæces*, which after ſome *remora* there regurgitate into what ſoon becomes the *rectum*, which, together with the excretories of the urine, and organs of generation, empties itſelf into the common *cloaca*. The ſmall *inteſtines* are connected by a long looſe *meſentery*, which has little or no fat accompanying the blood veſſels, there being no hazard of the blood's being ſtopped. There are no lacteal veſſels, *glandulæ vagæ* or *pancreas aſſellii* to be obſerved here. The *meſeraic veins* are proportionally very large, if you either compare them with the correſponding arteries, or conſider them with reſpect to the guts themſelves. The want of lacteals, *&c.* is ſupplied by theſe veins. As a proof of theſe having a communication with the guts, in larger fowls the guts can be diſtended by blowing in at the *meſeraic vein*; and from this difference of ſtructure, the uſe of the *glandulæ vagæ*, &c. can eaſily be aſſigned, *viz.* the *chyle* in theſe animals that have lacteals, being to be mixed with the blood in a conſiderable quantity at a time, leſt its particles ſhould attract one another ſtrongly, and ſo hinder this mixture; it was therefore neceſſary it ſhould be well diluted by the *humores iniquilini*, which bear a very great proportion to the quantity of pure *chyle*; ſince the *lymph* from the inferior extremities, *abdominal viſcera*, neck, *&c.* are poured into it. Here there was no hazard of any ſuch inconveniency by the *chyle* being mixed with the blood in ſmall proportion from the immenſe number of the ſmall extremities of the *meſeraic* veins.

The

The *pancreas* in the creature lies betwixt the two folds of the *duodenum*, and ſends two or three *ducts* into this gut pretty near the *biliary*.

The ſpleen is here of a round globular figure, ſituated between the liver and ſtomach, and betwixt theſe and the back bone it enjoys the ſame properties as in other animals, *viz*. large blood veſſels, &c. All its blood is ſent into the *vena portarum*, and has a perpetual conquaſſation. It has excretory as far as we know. Their liver is divided into two equal lobes by a *pellucid membrane*, running according to the length of their body; and hence we may obſerve, that it is not proper to that bowel to lie on the right ſide, which is ſtill more confirmed by what we obſerve in fiſhes, where it almoſt lies in the left ſide.

The ſhape of their gall-bladder is not much different from that of *quadrupeds*, but is thought to be longer in proportion to the ſize of the animal, and is farther removed from the liver; though in fiſhes it is ſtill further removed, not being at all contiguous; and in them the *ductus hepaticus* and *cyſticus* do not unite till juſt at the entry into the gut. In theſe animals, *viz* fiſhes, there ſeems to be no way of the *bile* getting into the gall-bladder but by regurgitation.

The principal difference to be remarked in their heart is the want of the *valvulæ tricuſpides*, and their place being ſupplied by one fleſhy flap.

The lungs are not looſe within the cavity of the *thorax*, but fixed to the bone all the way; neither are they divided into lobes, as in thoſe animals that have a large motion in their *ſpine*. They are two red ſpongy bodies covered with a *membrane* that is pervious, and communicates with the large *veſicles* or air bags that are diſperſed over their whole *abdomen*, which *veſicles* ſerve two very conſiderable uſes; the one is to render their bodies ſpecifically light, when they have a mind to aſcend and buoy themſelves up when flying, by diſtending their lungs

with air, and alſo ſtraiten their *trachea arteria*, and ſo return the air.

Secondly, they ſupply the place of a *muſcular diaphragm* and ſtrong *abdominal muſcles;* producing the ſame effects on the ſeveral contained *viſcera*, as theſe muſcles would have done without the inconveniency of their additional weight; and conducing as much to the excluſion of the egg and *fæces*.

The *trachea arteria*, near where it divides, is very much contracted, and their voice is principally owing to this coarction. If you liſten attentively to a cock crowing, you will be ſenſible that the noiſe does not proceed from their throat, but deeper; nay this very pipe, when taken out of their body and cut off a little, after its diviſion. and blown into, will make a ſqueaking noiſe, ſomething like the voice of theſe creatures. On each ſide, a little higher than this contraction, there is a muſcle ariſing from their *ſternum*, which dilates the *trachea*. The *cartilages*, of which the pipe is compoſed in this animal, go quite round it; whereas in men and *quadrupeds*, they are diſcontinued for about one fourth on the back part, and the intermediate ſpace filled up by a *membrane*. Neither is the *trachea* ſo firmly attached to their *vertebræ* as in other creatures we have examined. This ſtructure we ſhall find of great ſervice to them, if we conſider, that had the ſame ſtructure obtained in them as in us, their breath would have been in hazard of being ſtopped at every flexion or twiſting of their neck, which they are frequently obliged to. This we may be ſenſible of by bending our necks conſiderably on one ſide, upon which we ſhall find a great ſtraitneſs and difficulty of breathing; whereas their *trachea* is better fitted for following the flexions of the neck by its looſe connection to the *vertebræ*: and as from the ſtructure of the *trachea* it cannot yield to every cauſe diſtending the *œſophagus* as in us, it was proper they ſhould be placed at a greater diſtance from each other, which we accordingly find they are.

In

In place of a *muſcular diaphragm*, this creature has nothing but a thin *membrane* connected to the *pericardium*, which ſeparates the *thorax* and *abdomen*. But beſides this, the whole *abdomen* and *thorax* are divided by a longitudinal *membrane* or *mediaſtinum* connected to the lungs, *pericardium*, liver, ſtomach, and to the fat lying over their ſtomach and guts, which is analogous to an *omentum*, and ſupplies its place.

The kidneys lie in the hollow excavated in the ſide of the back-bone, from which there is ſent out a blueiſh coloured canal, running along by the ſide of the *vas deferens*, and terminates directly into the common *cloaca*. This is the *ureter*, which opens by a peculiar aperture of its own, and not at the *penis*. This creature having no *veſica urinaria*, it was thought by ſome they never paſſed any urine, but that it went to the nouriſhment of the *feathers*, but this is falſe; for that whitiſh ſubſtance that you ſee their greeniſh *fæces* covered with, and which turns afterwards chalky, is their urine. Let us next conſider the organs of generation of both ſexes, and firſt thoſe of the male.

The *teſticles* are ſituated one on each ſide of the back-bone, and are proportionally very large to the creature's bulk. From theſe run out the *vaſa ſeminifera*, at firſt ſtreight, but after they recede farther from the body of the *teſticle*, they acquire an undulated or convoluted form, as the *epididymis* in man. Theſe convolutions partly ſupply the want of *veſiculæ ſeminales*, their coition being at the ſame time very ſhort; theſe terminate in the *penis*, of which this creature has two, one on each ſide of the common *cloaca*, pointing directly outwards, and are very ſmall and very ſhort, hardly ſo big as a millet ſeed; whence they have eſcaped the notice of anatomiſts, who have often denied their exiſtence. This is what is chiefly remarkable in the organs of the male.

The *racemus vitellorum* being analogous to the *ovaria* in the human ſubject, are attached by a proper

membrane to the back bone This is very fine and thin, and continued down to the *uterus*. Its orifice is averſe with reſpect to the *ovaria*, yet notwithſtanding, by the force of the *orgaſmus venereus*, it turns round and graſps the *vitellus*, which in its paſſage through this *duct*, called the *infundibulum*, receives a thick gelatinous liquor, ſecreted by certain glands. This, with what it receives in the *uterus*, compoſe the white of the egg By this tube then it is carried into the *uterus*.

The *uterus* is a large bag, placed at the end of the *infundibulum*, full of wrinkles on its inſide; here the egg is completed, receiving its laſt *involucrum*, and the ſhell is at laſt puſhed out at an opening in the ſide of the common *cloaca*. From the *teſtes* in the male being ſo very large, in proportion to the body of the creature, there muſt neceſſarily be a great quantity of *ſemen* ſecerned; hence the animal is ſalacious, and becomes capable of impregnating ſo many females. The want of the *veſiculæ ſeminales* is in ſome meaſure ſupplied by the convolutions of the *vaſa deferentia*, and by the ſmall diſtance betwixt the ſecerning and excretory organs. The two *penes* contribute alſo very much to their ſhort coition, at which time the opening of the *uterus* into the *cloaca* is very much dilated, that the effect of the *ſemen* on the *vitelli* may be the greater.

A hen will of herſelf indeed lay eggs, but theſe are not impregnated, and yet appear entirely complete, except that the ſmall black ſpot, which comes afterwards to be the rudiments of the chick, is not here to be obſerved. After having obſerved the contents of the *abdomen* and *thorax*, we next proceed to examine the parts about the neck and head.

Theſe creatures, as was obſerved of fowls in general, have no teeth, which would have been needleſs, as they ſwallow their food entire; but their tongue is made pretty firm, leſt it ſhould be hurt by the ſharp points of the grain they feed on. It is of a triangular figure, and pointed before; and as by the depending

poſture

posture their meat is in hazard of falling out of their mouths; to prevent this, there are several small pointed *papillæ* standing out upon their tongue and palate, with their points inclined backwards, allowing an easy passage to the food, but hindering its return.

We have here no *velum palatinum*, *uvula* or *epiglottis*, and in place of two large holes opening into the nose, there is only a long narrow *rima* supplied with pretty strong muscles, and such another supplies the place of a *glottis*. The creature has a power of shutting both at pleasure, and the nature of their food seems not only to exempt them from the hazard of its getting into the nose or *trachea*, but its sharp points would hurt an *uvula*, or *epiglottis*, if they had any. Hence we see with what difficulty they swallow dough or other sort of food that can be easily moulded into any form.

Their *cranium* is more *cellular* and *cavernous* than ours; by this means their heads are light, yet strong enough to resist external injuries; for the enlarging the diameter of the bones contributes to their strength. By this *cavernous cranium* the organ of smelling is considerably enlarged; and further, singing birds, as is observed by Mr Ray and Mr Derham, have this *cavernous* structure of the brain still more observable; and we are told that the cavity of the *tympanum* communicates with the cells; but this I am apt to believe, so far as I could find from dissection, is rather founded on theory than matter of fact. Their brain is covered with the common *membranes*, but its external surface is not formed into so many *gyræ* or convolutions, as ours. Its anterior part is quite solid, of a cineritious colour, and so far has a resemblance of the *corpora striata*, as to give rise to the *olfactory nerves*. The whole of it appears to us as imperfect, and we can scarce determine whether there be any thing analogous to a third or fourth ventricle; neither the *corpus callosum*, *fornix*, *nates*, or *testes*, &c. can be observed here; which parts therefore cannot be imagined as absolutely necessary

ceſſary for the functions of life, ſince we find theſe creatures perform them ſufficiently well. We may perhaps think theſe ſerve a particular uſe in man, who is a rational creature, but then *quadrupeds* enjoy them in common with man. Theſe protuberances, &c. ſeem rather to depend on the different diſpoſition of the ſeveral parts, being variouſly connected and meeting in different directions in different places, than their being abſolutely neceſſary for any particular uſe, and the uſes that have been aſſigned to different parts of the brain by authors, ſeem to me to have no foundation but in the author's fancy. I have already owned my ignorance of the uſes of the particular parts of the brain, ſo ſhall not pretend to give reaſons for their being different in different animals; but all ſeem to agree in this, that the *cerebrum* has always hollows and vacuities in it, but the *cerebellum* none.

Their organ of ſmelling is very large and well provided with nerves; hence they have this ſenſation very acute. Ravens and other birds of prey give a ſure proof of this by their being able to find out their prey though concealed from their ſight, and at a conſiderable diſtance.

Thoſe birds that grope for their food in the waters, mud, &c. have large nerves which run quite to the end of their bills, by which they find out and diſtinguiſh their food.

The anterior part of their eyes (inſtead of having the *ſclerotic* coat continued, ſo as to make near a ſphere as in us) turns all of a ſudden flat; ſo that here the *ſclerotic* makes but half a ſphere; and the *cornea* riſes up afterwards, being a portion of a very ſmall and diſtinct ſphere; ſo that in theſe creatures there is a much greater difference betwixt the *ſclerotic* and *cornea* than in us. Hence their eyes do not jut out of their heads as in man and *quadrupeds*. As moſt of theſe creatures are continually employed in hedges and thickets, therefore that their eyes might be ſecured from theſe injuries, as well as from too much light when flying in the face of the ſun, there is a

a very elegant mechanifm in their eyes, which is a *membrane* rifing from the internal *canthus* of the eye, which at pleafure, like a curtain, can be made to cover the whole eye, and this by means of a proper mufcle that rifes from the *fclerotic* coat and paffing round the *optic nerves* runs through the *mufculus oculi attollens* (by which however the *optic nerves* are not compreffed) and *palpebra* to be inferted into the edge of this *membrane*. Whenever this mufcle ceafes to act, the *membrane* by its own elafticity again difcovers the eye. This covering is neither *pellucid* nor *opaque*; both which would have been equally inconvenient, but being fomewhat tranfparent, allows as many rays to enter as to make any object juft vifible, and is fufficient to direct them in their progreffion. By means of this *membrane* it is faid that the eagle is faid to look at the fun. *Quadrupeds*, as we mentioned before, have a *membrana nictitans*; but then it only can cover that part of the eye which is never covered by their eye-lids.

Befides, all fowls have another particularity, whofe ufe I think is not fo well underftood, and that is a pretty long black triangular purfe rifing from the bottom of their eye juft at the entry of the *optic nerve*, and ftretched out into their vitreous humour, and one would imagine it gave fome threads to the cryftalline. This the French (who as far as I know, were the firft who took notice of it in their diffections before the Royal Academy) give the name of *bourfe noire* to. This may poffiby ferve to fuffocate fome of the rays of light, that they may fee objects more diftinctly without hurting their eyes. It has a connection with the vitreous, and feems to be joined alfo to the cryftalline humour. If we fuppofe it to have a power of contraction, (which may be as well allowed as that of the *iris*,) it may fo alter the pofition of the vitreous and cryftalline humours, that the rays from any body may not fall perpendicularly upon the cryftalline, and this feems to be neceffary in them, fince they cannot change the figure of the anterior part of their eye fo much as we can do; and as this animal

is

is expofed often to too great a number of rays of light, fo they having no *topetum*, have the bottom of their eye wholly black on the *retina*, and in confequence of this fowls fee very ill in the dark.

They have no external ear, but in place thereof a tuft of very fine feathers covering the *meatus auditorius*, which eafily allow the rays of found to pafs them, and likewife prevent duft, or any infect from getting in. An external ear would have been inconvenient in their paffing through thickets and in flying, &c. A liquor is feparated in the external part of the ear or *meatus auditorius* to lubricate the paffage, and further prevent the entrance of any infects, &c. The *membrana tympani* is convex externally, and no mufcles are fixed to the bones of their ear, which are rather of a cartilaginous confiftence; any tremulous motions impreffed on the air are communicated in thefe creatures, merely by the fpring and elafticity of thefe bones, fo probably the *membrane* is not fo diftended as in the human ear, where this is done by mufcles. The *cochlea* and *femicircular canals* are very diftinct and eafily prepared.

The Anatomy of a carnivorous Fowl.

WE come next to the birds of prey, and for an example fhall take a ftenhil. The principal difference to be obferved in them, is in their *chylopoietic vifcera*, which may be accounted for from their different way of life.

Immediately under their *clavicles*, you will obferve the *œfophagus* expanded into their *ingluvies*, which is proportionally lefs than in the *granivorous* kind, fince their food does not fwell fo much by maceration, and for the fame reafon, there is a lefs quantity of a *menftruum* to be found here.

They have alfo a *ventriculus fuccenturiatus* plentifully ftored with glands, fituated immediately above their ftomach, which we fee here is evidently *membranous*,

branous, otherwiſe than in the *granivorous* kind, and this difference, which is almoſt the only one we ſhall find betwixt the two different ſpecies of fowls, is eaſily accounted for from the nature of their food, which requires leſs attrition, being eaſier of digeſtion than that of the other kind; nevertheleſs it ſeems requiſite it ſhould be ſtronger than the human, to compenſate the want of *abdominal* muſcles, which are here very thin.

The ſame mechaniſm obtains in this creature's *duodenum*, that we have hitherto obſerved. As being a *carnivorous* animal its guts are proportionally ſhorter than thoſe of the *granivorous* kind, for the reaſon firſt given, *viz.* its food being more liable to corrupt, therefore not proper to be long detained in the body, and for that reaſon it has no *inteſtina cœca*, of which the other ſpecies of fowls have a pair. The difference in their wings, backs and claws are obvious, and have been already in ſome meaſure obſerved.

There is a full deſcription of the different parts of the egg, with the changes that happen in the time of incubation, in the ſecond volume of the *Medical Eſſays*.

The Anatomy of Fiſhes.

AQueous animals are generally divided into ſuch as have lungs, and ſuch as want them. The firſt ſpecies differ very inconſiderably from an ox or any other *quadruped*, and are not eaſily procured, ſo that all I have to ſay on fiſhes, ſhall be taken from that ſpecies, which is not provided with reſpiratory organs.

Of theſe we may firſt obſerve, that they have a very ſtrong thick *cuticle* compoſed evidently of a great number of ſcales laid one on another like the tiles of houſes; this among other arguments ſerves to prove the human *epidermis* to be of a ſquamous ſtructure.

ſtructure. In the next place theſe creatures have neither anterior nor poſterior extremities, as *quadrupeds* and fowls: For their progreſſion is performed in a different way from either of theſe ſpecies of animals; for this purpoſe they are provided with machines properly conſiſting of a great number of elaſtic beams, connected to one another by firm *membranes*, and with a tail of the ſame texture; their *ſpine* is very moveable towards the poſterior part, and the ſtrongeſt muſcles of their bodies are inſerted there. Their tails are ſo framed as to contract to a narrow ſpace when drawn together to either ſide, and to expand again when drawn to a ſtreight line with their bodies, ſo by the aſſiſtance of this broad tail, and the fins on their ſides, they make their progreſſion much in the ſame way as a boat with oars on its ſides and rudder at its ſtern. The perpendicular fins ſituated on the ſuperior part of their body keep them in *æquilibrium*, hindering the belly from turning uppermoſt, which it would readily do, becauſe of the air bag in the *abdomen* rendering their belly ſpecifically lighter than their back, but by the reſiſtance theſe fins meet with when inclined to either ſide, they are kept with their backs always uppermoſt. The beſt account of this matter we have in the treatiſe before mentioned, *viz. Borelli de Motu Animalium*, part I. chap. 23.

It may be next obſerved, that theſe creatures have nothing that can be called a neck, ſeeing they ſeek their food in an horizontal way, and can move their bodies either upwards or downwards as they have occaſion by the contraction or dilatation of their air bag; a long neck, as it would hinder their progreſſion, would be very diſadvantageous in the element they live in.

The *abdomen* is covered on the inferior part with a black-coloured thin *membrane* reſembling our *peritoneum*. It is divided from the *thorax* by a thin *membranous* partition which has no muſcular appearance, ſo

ſo that we have now ſeen two different ſorts of animals that have no muſcular *diaphragm*.

These creatures are not provided with *teeth* proper for breaking their aliment into ſmaller morſels, as the food they uſe is generally ſmall fiſhes or other animals that need no trituration in the mouth, but ſpontaneouſly corrupt and gradually diſſolve into a liquid *chyle*. Their *teeth* ſerve to graſp their prey and hinder the creatures they have once catched from eſcaping again. For the ſame purpoſe the internal *cartilaginous* baſis of the *bronchi*, and the two round bodies ſituated in the poſterior part of the jaws, have a great number of tenter-hooks fixed into them in ſuch a manner, as that any thing may eaſily get down, but is hindered to get backwards. The water that is neceſſarily taken in along with their food in too great quantities to be received into their jaws in deglutition, paſſes betwixt the *interſtices* of the *bronchi*, and the flap that covers them. The compreſſion of the water on the *bronchi* is of conſiderable uſe to the creature, as we ſhall explain by and by.

The *œſophagus* in theſe creatures is very ſhort, and ſcarcely diſtinguiſhed from their ſtomach, ſeeing their food lies almoſt equally in both. The ſtomach is of an oblong figure. There are commonly found ſmall fiſhes in the ſtomach of large ones, ſtill retaining their natural form, but when touched they melt down into a jelly. From this and the great quantity of liquors poured into their ſtomachs, we may conclude that digeſtion is ſolely brought about in them by the diſſolving power of a *menſtruum*, and that no trituration happens here

The guts in theſe animals are very ſhort, making only three turns, the laſt of which ends in the common *cloaca* for the *fæces*, *urine* and *ſemen*, ſituated about the middle of the inferior part of their bodies.

What I call *pancreas*, ſome gave the name of *inteſtinula cæca* to; it conſiſts of a very great number of ſmall threads, like ſo many little worms, which all terminate

terminate at laſt in two larger canals, that open into the firſt gut, and pour into it a viſcous liquor, much about the place where the *biliary ducts* enter. Their *inteſtines* are connected to the back bone by a *membrane* analogous to a *meſentery*. No *lacteals* have been yet obſerved, and it is probable their aliment is taken in by the *meſeraic* veins.

Their liver is very large, of a whitiſh colour, and lies almoſt in the left ſide wholly, and contains a great deal of fat.

The gall-bladder is ſituated a conſiderable way from the liver, and ſends out a canal, the *cyſtic duct* which joins with the *hepatic duct* juſt at the entry into the gut; ſome fibres are ſtretched from the liver to the gall bladder, but none that I know of have hitherto diſcovered any cavity in theſe cords; ſo in this animal it ſhould ſeem impoſſible that the *bile* can be carried into the gall-bladder in the ordinary way, and conſequently muſt either be ſecerned on the ſides of that *ſac*, or regurgitate into it from the *canalis choledochus*.

The *ſpleen* is placed near the back-bone, and at a place where it is ſubjected to an alternate preſſure from the conſtriction and dilatation of the air-bag, which is ſituated in the neighbourhood. Since in all the different animals we have diſſected, we find the *ſpleen* attached to ſomewhat that may give it a conquaſſation, as in the human ſubject and *quadrupeds*, it is contiguous to the *diaphragm*, in fowls it is placed betwixt the back-bone, the liver and ſtomach, in fiſhes it lies on the *ſacus ærias*, and ſince we find it ſo well ſerved with blood-veſſels, and all its blood returning into the liver, we muſt not conclude the *ſpleen* to be an *inutile pondus*, only to ſerve as a balance to the animal *pro æquilibrio*, but particularly deſigned for preparing the blood to the liver.

The only organs of generation in this animal are two menſtruous bags ſituated in the *abdomen* uniting near the *podex*. Theſe in the male are filled with a whitiſh

whitiſh firm ſubſtance called the *milt*, and in the female with an infinite number of little *ova* cluſtered together, of a reddiſh yellow colour called the *roe*. Both theſe at ſpawning time we find very much diſtended, whereas at another time the male organs can ſcarce be diſtinguiſhed from the female, nor is there any proper inſtrument in the male for throwing the ſeed into the organs of the female as in other creatures. I ſhall not take upon me to determine the way whereby the female ſperm is impregnated, but we find that the ſpawn of frogs conſiſts in the ſmall ſpecks wrapt up in a whitiſh glutinous liquor; theſe ſpecks are the rudiments of the young frogs which are nouriſhed in that liquor, till they are able to go in ſearch of their food. In the ſame way the *ova* of fiſhes are thrown out and depoſited in the ſand, the male being for the moſt part ready to impregnate them, and they are incubated by the heat of the ſun. It is curious enough to remark with what care they ſeek for a proper place to depoſite their *ova*, by ſwimming to the ſhallow, where they can better enjoy the ſun's rays, and ſhun the large jaws of other fiſhes. The river fiſhes again ſpawn in ſome creek free from the hazard of the impetuous ſtream. But whether this mixture be brought about in fiſhes by a ſimple application of the genitals to each other, or if both of them throw out their liquors at the ſame time in one place, and thus bring about the deſired mixture, is not eaſy to determine; the latter I think, ſeems moſt probable. These creatures are ſo ſhy that we cannot poſſibly get to obſerve their way of copulation, and are conſequently but little acquainted with their natural hiſtory.

After raiſing up the black *peritoneum*, there comes in view an oblong white membranous bag, in which there is nothing contained but air. This is the ſwimming-bladder; it lies cloſe to the back-bone, and has a pretty ſtrong muſcular coat, whereby it can contract itſelf. By contracting this bag, they can make the muſcles ſpecifically heavier than water,

and ſo readily fall to the bottom; whereas the *muſcular fibres* ceaſing to act, they become ſpecifically lighter than water, and ſo ſwim above According to the different degrees of contraction and dilatation of this bladder, they can keep higher or lower in the water at pleaſure. Hence flounders, ſoles, raia and ſuch other fiſhes as want this *ſac*, are found always groveling at the bottom of the water: It is owing to this that dead fiſhes (unleſs this *membrane* has been previouſly broke) are found ſwimming a-top, the *muſcular fibres* then ceaſing to act, and that with their bellies uppermoſt; for the back-bone cannot yield, and the diſtended *ſac* is protruded into the *abdomen* and the back is conſequently heavieſt at its upper part according to their poſture. There is here placed a glandular ſubſtance containing a good quantity of red blood. and all the *red* in their body is contiguous to this air-bag, excepting the guts. From the anterior part of the bag go out two *proceſſes* or *appendices*, which, according to the gentlemen of the French Academy, terminate in their fauces: but I never could find out this communication either by tracing them, pouring in mercury or water, &c. I put, it is true, a probe through them, but then with the ſame ſtrength I could have put it through the ſides of the *proceſſes*, ſo that I am afraid this is *gratis dictum*, and that there is here as in ſome other places of the human body an *aer inſitus*.

At the ſuperior part of this bag there are other *red* coloured bodies, of a glandular nature, which are connected with the kidneys. From them the *ureters* go down to their inſertion in the *veſica urinaria*, which lies in the lower part of the *abdomen*, and the *urethra* is there produced, which terminates in the *podex*.

Theſe laſt mentioned parts have not hitherto been obſerved in ſome ſpecies of fiſhes, whence authors too haſtily denied them in all. Theſe creatures have a *membranous diaphragm* which forms a *ſac*, in which the

the heart is contained. It is very tenſe, and almoſt perpendicular to the *vertebræ*.

The heart is of a triangular form, with its baſe downwards, and its *apex* uppermoſt, which ſituation it has becauſe of the *branchiæ*. It has but one *auricle* and one *ventricle*, becauſe they want lungs; and one great artery. The ſize of the *auricle* and *ventricle* are much the ſame; the artery ſends out numberleſs branches to the *branchiæ* or gills.

The *branchiæ* lie in two large ſlits at each ſide of their heads, and ſeem to be all they have that bears any analogy to lungs. Their form is ſemicircular; they have a vaſt number of *red fibrillæ* ſtanding out on each ſide of them, like a fringe, and very much reſemble the vane of a feather. Theſe *branchiæ* are perpetually ſubjected to an alternate motion and preſſure from the water; and we may here remark, that we have not found any *red* blood but in places ſubjected to this alternate preſſure; this obſervation will help us in explaining the action of the lungs upon the blood. Over theſe gills there is a large flap, allowing a communication externally, by which the water they are obliged to take into their mouths with their food, finds an exit without paſſing into their ſtomach; it is owing to theſe flaps coming ſo far down that the heart is ſaid commonly to be ſituated in their heads.

Their brains are formed pretty much in the ſame way as that of fowls, only we may obſerve that the poſterior lobes bear a greater proportion to the anterior.

Their organ of ſmelling is large, and they have a power of contracting and dilating the entry into their noſe as they have occaſion. It ſeems to be moſtly by their acute ſmell that they diſcover their food; for their tongue ſeems not to have been deſigned for a very nice ſenſation, being of a pretty firm cartilaginous ſubſtance, and common experiment evinces that their ſight is not of ſo much uſe to them as their ſmell in ſearching for their nouriſhment. If you

throw a fresh worm into the water, a fish shall distinguish it at a considerable distance, and that this is not done by the eye, is plain from observing, that after the same worm has been a considerable time in the water and lost its smell, no fishes will come near it; but if you take out the bait and make several little incisions into it, so as to let out more of the odoriferous effluvia, it shall have the same effect as formerly. Now it is certain, had the creatures discovered this bait with their eyes, they would have come equally to it in both cases: In consequence of their smell being the principal means they have of discovering their food, we may frequently observe their allowing themselves to be carried down with the stream, that they may ascend again leisurely against the current of the water; thus the odorous particles swimming in that medium being applied more forcibly to their smelling organs, produce a stronger sensation.

The *optic nerves* in these animals are not confounded with one another in their middle progress betwixt their origin and the orbit, but the one passes over the other without any communication, so that the nerve that comes from the left side of the brain goes distinctly to the right-eye: And *vice versa*.

The *lens crystallina* is here a compleat sphere, whereas in men and all other terrestrial animals it consists of two portions of unequal spheres laid on one another; to account for this, it must be considered that these creatures have got no aqueous humour, as the rays that come to their eyes are conveyed through a *medium* of the same density with that humour in other animals, and consequently would have gone on in a streight line without any refraction till they come to the *lens*, although they had been provided with an aqueous humour; thus then the rays impinging upon their *lens* have hitherto suffered no refraction; that they might therefore be sufficiently refracted and meet in a point on the *retina*, it was necessary the *lens* should be made more

convex

convex than it is in other creatures who have the rays confiderably refracted in their paffage from the air through the aqueous humour.

As fifhes are continually expofed to injuries in the uncertain element they live in, and as they are in perpetual danger of becoming a prey to the larger ones, it was neceffary their eyes fhould never be fhut, and in confequence of this they are not provided with *palpebræ*; but then as in the current itfelf the eye muft be expofed to feveral injuries, there was a neceffity it fhould be fufficiently defended, which in effect it is by a firm *pellucid membrane* that feems to be a continuation of the *cuticula*, being ftretched over here. The *epidermis* is very proper for this purpofe, as being infenfible and deftitute of veffels, and confequently not liable to obftructions, or by that means, of becoming opake.

Whether fifhes have a fenfe of hearing or not, is very uncertain: All that has the appearance of an organ of hearing in thefe creatures is a bone, about the bulk of one half of a common bean of a particular ftructure, being very brittle and compofed of a great many different *fegments* laid at one anothers fides, and fituated in a particular form at the fide of the brain; is then the idea of found communicated to them by means of this bone? Or does their running away, at ftamping hard on the ground or crying loud, depend, upon fome other kind of fenfation? This may poffibly be produced in them, by a tremulous motion communicated to their bodies by the circumambient water, which is put in agitation, from the like concuffions happening in the air or neighbouring ground.

F I N I S.